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Dynamics of Household Heads' Intentions to Adopt Biogas Technology in Ghana

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Authors' contributions

This work was achieved in collaboration with all authors. Author MOM did the conceptualization, methodology, formal analysis, investigation, data curation and writing-original draft preparation. Authors NV and EA did the supervision, writing- reviewing and editing. All authors read and approved the final manuscript.

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ABSTRACT

Evidence abounds that biogas technology has enormous health and environmental benefits, including improvement of community livelihood and health, sanitation, sustainable energy and reduced emissions. In spite of these benefits, intentions to adopt biogas technology are low among household heads in developing countries, notably Ghana. This study aimed to investigate the dynamics of household heads' intentions to adopt biogas technology, based on the theory of planned behavior. The study adopted an exploratory design and collected data from 394 household heads' using questionnaires. It was discovered that attitude, subjective norms and perceived behavioral control are significant predictors and independently contributed to predicting household heads' intentions to adopt biogas technology. Additionally, the study found that, the dynamics of ethnicity and education have a significantly direct effect on household heads' intentions to adopt biogas technology. The study recommends that respected persons in local communities, using

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different ethnic dialects, lead public education and awareness creation on the benefits of the use of biogas technology. Besides, government should subsidize the cost of biogas plants installation so as to promote its adoption rate.

Keywords: Biogas technology; Ghana; theory of planned behavior; household heads; ethnicity; education.

1. INTRODUCTION

Globally, energy is one of the key requirements needed to improve all aspects of human life. Many empirical studies have shown that energy drives the economic growth and development of societies [1,2]. The energy demand increase with increase in population that emanates from urbanization and industrialization, which is characteristic of most developing countries. However, most developing countries have to deal with limited access to energy often resulting from energy crises, reliance on unsustainable sources of energy such as fossils and firewood, and their attending effect on the environment [3].

Owing to this, experts in energy resources have suggested that exploring renewable energy resources and technologies will result in sustainable energy management [4]. Furthermore, the Advisory Group on Energy and Climate Change [5] have proposed that the global community should be concerned with providing access to modern energy services by 2030. This places a clarion call on individuals, groups, academics, communities, non-governmental organizations (NGOs), civil society organizations (CSOs) as well as state and regional governments to make conscious efforts towards promotion of the use of renewable energy resources.

Biogas is a renewable energy that belongs to the biofuels category, which is obtained by the biological breakdown or decomposition of biodegradable matter in the absence of oxygen under controlled conditions. Its composition is largely methane (60-70%), carbon dioxide (30-40%) and other trace gases. Thus, biogas technology (BT) is a modern technique for processing organic waste from municipalities and industries into biogas and also, generating highly effective bio-fertilizer in the production process [6]. According to Amigun and Blottnitz [7], biogas technology provides an attractive route for partially meeting energy needs, and consequently overcoming energy poverty and its attendant effects on economic development in Africa. Research shows that although the technology has been in existence for many decades, its adoption is either still at the infant stage or the dissemination rate is very low in most developing countries [8].

Many experts and researchers consider BT as an excellent tool for improving human well-being, environmental quality, and macroeconomic benefits to societies. These benefits include improved sanitation, improved water quality, reduced indoor smoke, better lighting, reduced drudgery for women, generation of bio-fertilizer, conservation of resources (trees), reduced greenhouse gas emissions and creation of employment opportunities [7,9-11]. As such, of the seventeen sustainable development goals (SDGs), nine of them have a direct relation to renewable energy (i.e. SDG's 1, 2, 3, 5, 6, 7, 8, 13 and 15), thus underscoring the importance of renewable energy for the growth and development of nations.

In Ghana, it is pertinent to explore and tap into the enormous benefits of BT to help mitigate the intermittent energy crises and sanitation challenges that face the country, considering the fact that the waste stream in Ghana is mainly biodegradable. Excrement management including collection, transportation, disposal and treatment is a big challenge in Ghana. Studies have shown that even though collection and transportation have been consistent and seen improvement over the years, disposal and treatment are distressingly lagging behind [12,13] due to woefully inadequate treatment facilities. In extreme cases, excrement is discharged directly unto bare lands at dumpsites.

According to Osei-Marfo et al. [14], BT is gradually gaining popularity for excrement treatment at the household, institutional and industrial levels in Ghana. However, the authors further noted that the thrust has been low in spite of the known benefits of the technology. Just like implementation of any project, acceptance by the beneficiaries is vital to the success of the project. Accordingly, Michalisin et al. [15] have noted that

understanding the cognitive and motivational barriers, and dynamics of individuals who are unwilling to use a new technology could lead to improvement of efficiency and effectiveness. This emphasizes the extent to which intent affects adoption of a new technology by both individuals and communities.

Several works have been conducted to assess factors that influence the adoption of BT using different approaches such as questionnaires, interviews, focus group discussions and other equally good methodologies [8,16,17]. Most of the findings of these studies show a clear support for BT as an environmentally friendly technology that improves well-being, livelihood, provides bio-energy and reduces emissions. However, Gifford and Nilson [16] argue that lifestyle and behavior pattern cannot change by simply transmitting knowledge. This implies that acceptance of a new technology by members in a community requires the involvement of influential personalities in the society, such as household heads. Therefore, Ajzen [18] have noted that there is the need to identify the beliefs people hold towards an issue and how these beliefs affect their intentions and behavior rather than making sure people have accurate information.

Although some studies have researched on what influences the behavior of households to adopt BT [19-22], little is known about the dynamics of how Ghanaian household heads' intentions influence their decisions to either adopt or reject BT. Adoption and utilization of BT by households seem suitable for Ghana's waste characteristics, and considering the fact that the country has an average temperature of 30°C [23], which is suitable for facilitating anaerobic decomposition. However, for households to adopt BT depends largely on the decisions of the household heads.

Using the Theory of Planned Behavior (TPB) model, this study aims at improving an understanding of the dynamics of the intentions, and in effect decisions of household heads in Ghana to adopt BT as an alternative method for managing biodegradable waste and also obtaining bio-energy and bio-fertilizer for domestic use and agricultural purposes. The study examines the reasons why household heads will want to adopt BT from religious, cultural, resource availability, family (important persons) and environmental quality points of view. The outcome of this study would be crucial for developing interventions aimed at promoting the adoption of BT and develop a model, which could be used by policymakers in Ghana and other developing countries.

2. CONCEPTUAL FRAMEWORK

The Theory of Planned Behavior (TPB) is a psychological theory used in predicting and explaining human behavior (Fig. 1). According to the TPB, an individual's behavior is guided by three considerations: Beliefs about the likely consequences of the behavior (behavioral beliefs), beliefs about the normative expectations of others (normative beliefs) and beliefs about the presence of factors that may facilitate or hinder the performance of the behavior (control beliefs). Behavioral beliefs produce a favorable or unfavorable attitude towards the behavior; normative beliefs produce perceived social pressure or subjective norms; and control beliefs end in perceived behavioral control [24]. These three constructs, attitude towards the behavior, subjective norm and perceived behavioral control result in the formation of behavioral intention which may then lead into the actual action.

The direct path linking perceived behavioral control to behavior, models the actual behavioral control. Thus the extent to which one has the skills, resources and other conditions suitable for the performance of a particular behavior. Hence, the successful performance of a behavior does not only depend on favorable intention, but also on a reasonable level of behavioral control [25]. The model posits that people's attitudes towards behaviors are determined by their accessible beliefs about the behavior. In this case, belief is defined as the subjective probability that the behavior will produce a given outcome or experience. The expected outcome is assessed with the subjective evaluation of the outcome [26]. Attitude, subjective norm and perceived behavioral control are obtained by the product of behavioral beliefs and outcome evaluations; normative beliefs and motivation to comply; and control beliefs and perceived power to control respectively.

The behavior of interest in this study is household heads intention to adopt BT, which is the willingness to accept BT as an alternative method for managing domestic waste. Based on the considerations of TPB, the household head's consideration to adopt BT looks at waste

reduction, emission reduction and energy source. Thus, when household heads believe that adopting BT produces positive outcomes, they will have favorable behavior. On the other hand if they think otherwise, the behavior will be unfavorable. The household head's social norms refers the pressure of influencing or level of acceptance to adopt BT from important referents such as family, friends, neighbors, experts and fire personnel. The household head's perceived behavioral control refers to the ability to adopt BT, thus whether it will facilitate or impede the behavior [26-28]. Ajzen [27] argued that an individual's intention to adopt BT becomes stronger if attitude and subjective norm are favorable with regard to the behavior (BT adoption) and perceived behavioral control is greater.

Structural equation modeling (SEM) is used to analyze the predictive strength of these variables and to examine the relationship between the variables and the intentions of the household heads to adopt BT.

There are many behavioral theories that have been successfully used to address human behavior, however, since accepting and adopting BT as an alternative method for waste management appears to be a reasoned act, TPB seems to be useful and best option [29].

3. METHODOLOGY

This study was cross-sectional conducted in two peri-urban and urban communities in Cape Coast Metropolitan Area, Central and Accra Metropolitan Area, Greater Accra regions of Ghana. Central and Greater Accra regions were selected due to their cosmopolitan nature. These areas have a blend of rural, peri-urban and urban settlements with different cultural and ethnic groupings. Data for the study was gathered using a random sampling technique. The study used the TPB to assess the predictive power of the theory's constructs on household heads' intentions to adopt BT as an alternative method for waste management.

3.1 Pilot Study

The study began with an elicitation for accessible beliefs from a sample of respondents prior to designing the TPB questionnaire. A pilot study was conducted among local residents in the study areas involving 108 respondents (40 females, 68 males). This involved an open-ended questionnaire administered to capture their readily accessible beliefs about adopting biogas technology. It was explained that their opinions about adopting biogas technology were being sought so they should write whatever comes to mind. They were specifically asked to write their opinion on (a) the advantages and disadvantages of adopting biogas technology as an alternative method for waste management, (b) to state the persons or groups of people who would approve or disapprove of their actions of adopting biogas technology as an alternative for waste management, (c) the factors that could either facilitate or prevent them from adopting biogas technology. Subsequently, a content analysis of the responses was conducted to ascertain frequencies of responses. The most frequent responses were included in the development of the TPB questionnaire. This was done by tallying the number of a particular response given [24,26].

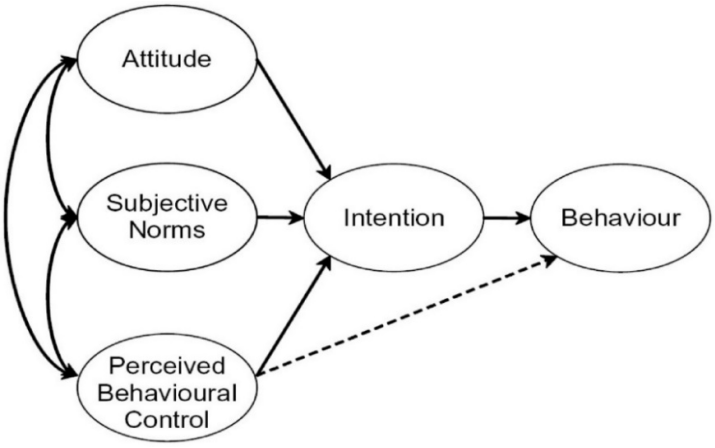

Fig. 1. The theory of planned behavior model [28]

A pre-test of the questionnaire was conducted among 118 local residents in the study area prior to the main study. The pre-test was conducted to test the consistency, clarity, understandability and psychometric properties of the questionnaire. The questions were then modified to correct any ambiguous wordings. A Cronbach's alpha of 0.685 was obtained, indicating that the scales were adequate.

3.2 The Main study

The study was conducted in July-September 2017 and members within the study area were approached by the researcher to inquire for their consent to participate in the study. Before administering the questionnaire, the aim of the study was explained to the participants. The questionnaire had two sections: demographics for the first section and the TPB constructs for the second section. The items in the second section were measured on a 7-point Likert scale. Six trained research assistants supported respondents who had difficulty in answering the questionnaires. The questionnaires were administered in an ordinary house setting.

3.3 Questionnaires

3.3.1 Attitude (A)

Attitude was measured with 3 items using behavioral beliefs and their outcome evaluation. The questions in the questionnaire assessed the advantages and disadvantages of adopting BT. The salient beliefs identified include emission reduction, waste reduction and energy source.

3.3.2 Subjective norms (SN)

Subjective norm was measured using normative beliefs and their motivation to comply. A total of 5 items were used to assess respondent's normative beliefs and their motivation to comply. Respondents were asked to rate particular important people in their lives who would approve or disapprove of their adoption of BT and whether their opinion had any influence on their decision to either adopt or not to adopt BT.

3.3.3 Perceived behavioral control (PBC)

Perceived behavioral control was measured with 3 items using control beliefs and power of control factors. The questionnaire assessed the factors which may enable or prevent respondents' ability to adopt BT.

3.3.4 Intentions (I)

The intentions of participants were measured using three items. They were asked to indicate if they will make effort, if they intend and if they have plans to adopt BT.

4. DEMOGRAPHICS

The demographic information of respondents was obtained with 5- items specified in Table 1, reporting gender, age, education, ethnicity and religion.

4.1 Background Factors: Ethnicity and Education

According to Ajzen [30], background factors such as gender, age, ethnicity, education, income, nature of personality have the potential to influence the beliefs people hold. In order to further understand what could influence household heads' reasons for adopting BT, the potential impact of ethnicity and education were examined. It seems likely that ethnicity and education could influence the intentions of household heads in adopting BT hence these background factors are considered relevant in this study. Additionally, other studies have documented significant impacts of ethnicity and education on the adoption of BT [2,19,31], therefore gaining further insight will be useful for this study.

5. STATISTICAL ANALYSIS

During the study, 645 people were approached but responses were received from 438 people (68% response rate). The questionnaires which had any item vacant, was not included in the analysis, therefore 394 completed responses were coded and saved into IBM SPSS version 23. The TPB constructs were analyzed using factor analysis with SEM using SPSS Amos 23 with maximum likelihood estimation. The analyses were performed in two stages. First, the standard or original TPB model was tested for BT adoption. Second, to better understand the extent of influence ethnicity and education have on intentions, these background variables were introduced into the model [2,19,31].

5.1 Descriptive Analysis of Variables

The study framework contains three exogenous and one endogenous variable. Each variable had Cronbach alpha value above .60 as

recommended by Hair et al. [32] and Samuels [33]. A composite variable of each belief was obtained by multiplying each belief statement by its corresponding belief evaluation. Assessment of the model is done by using sample size-independent fit indices such as normed fit index (NFI), Tucker-Lewis index (TLI), comparative fit index (CFI) and root mean square error of approximation (RMSEA) [34,35]. Cangur & Ecran [36], and Hox & Bechger [37] have suggested that acceptable values for NFI, TLI and CFI should be at least 0.90 while values above 0.95 are classified as excellent, and RMSEA values smaller than 0.08 classified as acceptable while values less than 0.06 classified as excellent.

6. RESULTS

6.1 Demographic Characteristics

The demographic profile of the respondents is presented in Table 1. The respondents' ages ranged between twenty to above sixty, with thirty-one to forty (39.1%) being the majority. The descriptive statistics indicate that the respondents were dominated by males (76.6% male), which is a representation of household heads in the study area. The majority of the respondents had tertiary education (33.5%), implying their understanding of the questionnaire, and this is slightly above basic education (32.0%), which might pose a challenge of understanding the questionnaire. The majority of respondents were Akans (58.9%) and Christians (84.8%), reflecting the predominant ethnic group and religion in Ghana respectively [38].

6.2 Descriptive Statistics of Variables

Participants (n=394) showed relatively strong behavioral intentions (M = 5.86, SD = 1.57), favorable attitude (M = 12.70, SD = 8.57), moderately high social pressure (M = 11.31, SD = 7.30) and negative controllability (M = -9.50, SD = 8.38) to adopting biogas technology.

Additionally, Pearson's correlation matrix displayed in Table 2 indicates that just about all the TPB variables are significantly associated with intentions. The inter-item correlation vary from .135 to .392. From the results, it is clear that the significant predictors of household heads BT adoption intentions were attitude and social pressure. Perceived behavioral control, however, showed a negatively weak effect on intentions to adopt BT by household heads.

Table 1. The demographic profile of respondents (N= 394)

Demographics	Frequency	Valid percentage
Gender:		
Male	302	76.6
Female	92	23.4
Age:		
20-30	25	6.3
31-40	154	39.1
41-50	114	28.9
51-60	94	23.9
Above 60	7	1.8
Education:		
No formal education	58	14.7
Basic	126	32.0
Secondary	78	19.8
Tertiary	132	33.5
Ethnicity:		
Akan	232	58.9
Ewe	56	14.2
Northern	71	18.0
Ga-Adangbe	35	8.9
Religion:		
Christianity	334	84.8
Islam	49	12.4
Traditional	11	2.8

6.3 The Standard TPB Model

The standard TPB model for BT adoption by household heads is shown in Fig. 2. According to the test, this model accounted for 32% of the total variance in household heads' behavioral intentions to adopt BT. The model's fit indices (RMSEA=.080; NFI=.878; CFI=.908; TLI=.883) indicated a mediocre fit to the data.

Following the classification suggested by Cohen [39] classification, the standardized estimates showed that attitude (A) (β = .265, SE = .016, p< .001) had a moderate but significant influence on intentions, subjective norm (SN) (β = .478, SE = .032, p< .001) had a strong and significant influence on intentions while perceived behavioral control (PBC) (β = .246, SE = .019, p= .005) had a moderate but significant effect on intentions to adopt BT.

Furthermore, the direct relationships between the composite beliefs and the TPB latent variables were all high (βs range from .687 to .865, p< .001). This is an indication of high influence on respondents' latent variables on BT adoption.

With regards to the effects between the latent variables, attitude and subjective norm showed significantly positive effect (β = .627, SE = 2.447, p< .001), whereas both subjective norm and perceived behavioral control, and attitude and perceived behavioral control showed significantly negative effects (β = -.589, SE = 2.061, p< .001) and (β = -.469, SE = 2.302, p< .001) respectively. The positive value indicates that as social pressure increases, a positive attitude toward intention to perform the behavior also increases. On the other hand, the negative values indicate that when household heads perceive that controllability is difficult, social pressure may be of no importance and consequently a negative attitude may be developed towards adoption of BT.

6.4 Effects of Beliefs

The beliefs were examine to determine their effects. The 3 behavioral beliefs explained 59.7% of variance in attitude towards BT adoption by household heads. These beliefs were *"adopting biogas technology will help me reduce pollution/emission", "adopting biogas technology will help me reduce the volume of waste to the landfill/dumpsite/treatment plant"* and *"adopting biogas technology will provide me with energy source".* The effect of these beliefs include: emission reduction (β = .66, p<.001); waste volume reduction (β = .89, p<.001); and energy source (β = .71, p<.001).

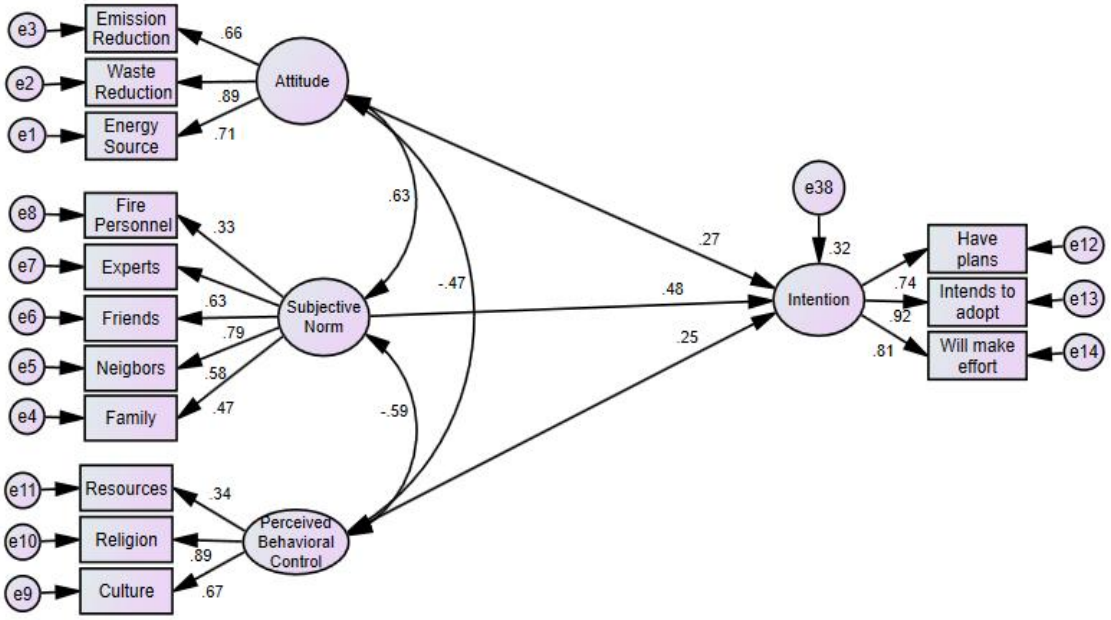

Fig. 2. Intention to adopt biogas technology

The 5 normative belief explained 73.4% of the variance in subjective norms towards intention to adopt BT. These normative beliefs were "*my family will approve of me adopting biogas technology", "my neighbors will approve of me adopting biogas technology", "my friends will approve of me adopting biogas technology", "environmental experts will approve of me adopting biogas technology" and "fire personnel will approve of me adopting biogas technology*". The effects of these beliefs on intentions to adopt BT is family (β = .47, p<.001); neighbors (β = .58, p<.001); friends (β = .79, p<.001); experts (β = .63, p<.001); and fire personnel (β = .33, p<.001).

The 3 control beliefs explained only 48% of the variance in perceived behavioral control towards intention to adopt BT. These beliefs were *"my cultural practices does not prevent me from adopting BT", my religious practices does not prevent me from adopting BT" and "lack/inadequate resources will prevent me from adopting BT"*. The effects of these beliefs on intention is culture (β = .67, p<.001); religion (β = .89, p<.001); and resources (β = .34, p<.001).

6.5 Modified TPB Model: Effects of Ethnicity and Level of Education

In the modified TPB model, ethnicity and level of education were introduced as background factors (Fig. 3). Results indicated an acceptable model fit for intentions to adopt BT (RMSEA=.071; NFI=.946; CFI=.965 TLI=.952) and explained 33% of the variance towards adoption intentions. Level of education had both direct (β = .130, SE = .060, p= .013) and indirect significant positive effect on intentions to adopt BT; thus level of education had direct effect on all 3 factors of attitude: emission reduction (β = .206, SE = .389, p < .001), waste reduction (β = .190, SE = .382, p < .001), and energy source (β = .118, SE = .343, p = .013), all 5 factors of subjective norms: family (β = .130, SE = .385, p = .007), neighbors (β = .137, SE = .327, p = .004), friends (β = .135, SE = .322, p = .003), experts (β = .223, SE = .292, p < .001) and fire personnel (β = .133, SE = .252, p = .007) and 1 factor for perceived behavioral control: resources (β = -.111, SE = .453, p = .020). For ethnicity, it had only a direct significantly negative effect on intentions to adopt

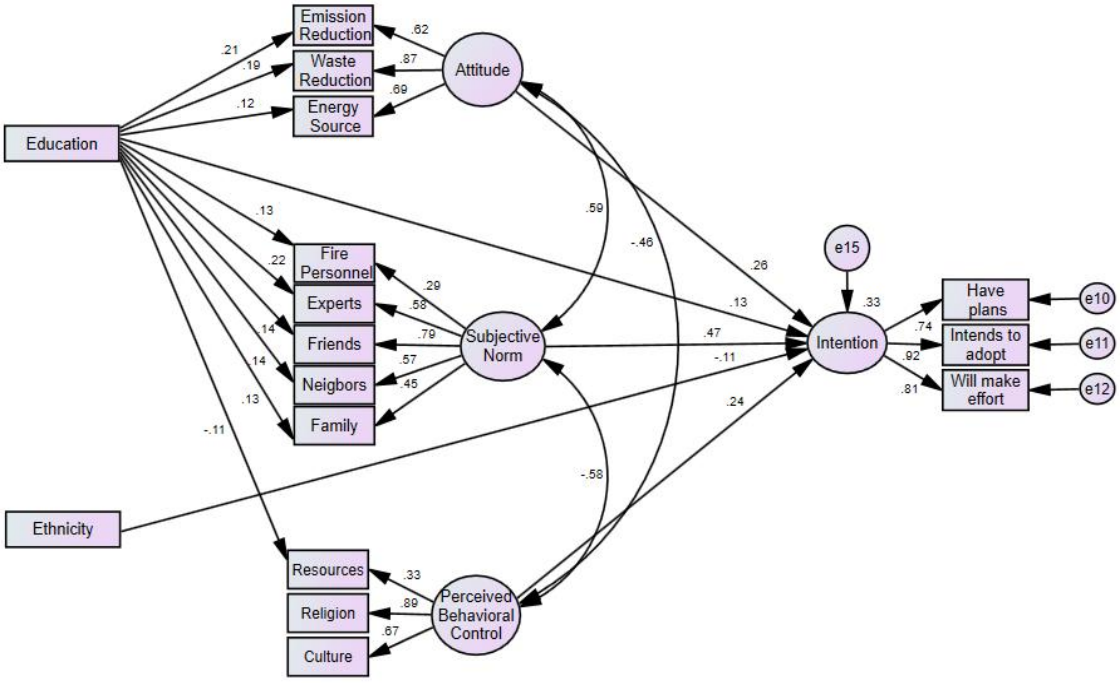

Fig. 3 Modified TPB model depicting effect of education and ethnicity on intentions to adopt biogas technology

Note: to avoid overloading the figure, only significant paths are displayed

BT (β = -.115, SE = .056, p=.014). Only significant paths have been shown to avoid overloading the figure.

7. DISCUSSION

This study tested the suitability of the use of the TPB framework to understand the dynamics of the intentions of household heads to adopt BT in Ghana. The results of this study confirm that all the constructs of the model, attitudes, subjective norms and perceived behavioral controls accounted for the proportion of variance in the dynamics of intentions to adopt BT. In terms of model comparison, the use of SEM revealed a mediocre fit for the standard TPB and an acceptable fit upon introduction of background factors (ethnicity and education) to the standard TPB model.

The introduction of ethnicity and education improved the model by an insignificant difference in the variance towards the dynamics of intentions to adopt BT. It was realized that ethnicity had a direct significantly negative influence towards intentions and this is supported by previous research [31]. This demonstrates that an individuals' ethnic background do matter when it comes to decisions relating to BT adoption, and this may negatively influence intentions towards the technology.

However, education had both direct and indirect significant effect towards dynamics of intensions to adopt BT. This finding is consistent with [20]. Education influences intentions indirectly by mediating through all factors of attitude, subjective norms, and perceived control through only resources. This suggests that one's level of education plays a key role towards intentions to adopt BT. Studies have shown that analytical capability of information and understanding of a technology are all linked to a person's level of education [20,31]. Therefore, the level of education will inform the level of comprehension of biogas technology and consequently its adoption.

The dynamics of household heads intentions to adopt BT appears to be influenced to a large extent by ethnicity and the educational level.

Highlights of the specific beliefs and factors that impacted largely respondents' dynamics of intentions to adopt BT are worth noting. It was revealed that intentions to adopt BT was affected by three behavioral beliefs (emission reduction, waste reduction and energy source), five normative beliefs (family, neighbors, friends, environmental experts and fire personnel) and one control beliefs (resources).

For behavioral beliefs, it was observed that emission reduction, waste reduction and energy source played a role in significantly influencing intentions to adopt BT which is supported by previous studies [19,20,31]. The use of BT and its associated benefits cannot be over emphasized. It was realized that respondents had a positive attitude, considering the fact that the use of a technology will consequently reduce emissions into the atmosphere, reduce waste volumes to landfill/dump sites and above all provide renewable energy for domestic purposes, which in effect will reduce the cost for buying energy. Thus respondents were interested in the quality or improvement of the environment. This suggests that interventions targeted at encouraging household heads to adopt BT would be highly effective if these benefits (emission reduction, waste reduction and energy source) are emphasized.

With regards to subjective norms, it was revealed that family, neighbors, friends, environmental experts and fire personnel were all having significant effect on intentions to adopt BT and this is consistent with similar study by Leeuw et al [26]. It was revealed that respondents have reverence for people they consider important in their lives and that the opinions of these important people could influence their intentions of adopting BT. These findings suggest that when designing interventions aimed at encouraging household heads to adopt BT, family members, neighbors, friends, experts and fire personnel add up to the dynamics and they could be involved to facilitate or play key role in the campaign for BT adoption.

Nonetheless, for perceived behavioral control, only resources had a significant influence on intention dynamics to adopt BT and this is supported by a similar study [14]. It was revealed that respondents showed moderately negative control towards intentions to adopt BT. The initial investment cost for the installation of a biogas plant, periodic maintenance cost, the capacity of service providers (human resource) are examples of perceived control factors which negatively influence household heads intentions to adopt BT as reported by Osei-Marfo et al. [14].

Table 2. Cronbach's alpha, grand means, standard deviations, variable means and correlation between all variables

Latent	Cronbach's Alpha	Mean (SD)	Variables	Mean	Correlation matrix													
					1	2	3	4	5	6	7	8	9	10	11	12	13	14
Attitude	.782	12.70 [a] (8.57)	1 Emission reduction	11.78 [b]	1													
			2 Waste volume reduction	12.67 [b]	.598**	1												
			3 Reliable energy source	13.66 [b]	.411**	.628**	1											
Subjective Norm	.692	11.31 [a] (7.30)	4 Family	10.93 [b]	.197**	.238**	.259**	1										
			5 Neighbors	9.53 [b]	.172**	.167**	.192**	.375**	1									
			6 Friends	10.52 [b]	.338**	.376**	.314**	.401**	.541**	1								
			7 Environmental experts	14.44 [b]	.378**	.497**	.441**	.243**	.279**	.444**	1							
			8 Fire personnel	11.14 [b]	.220**	.315**	.251**	.116*	.129*	.204**	.312**	1						
Perceived Behavioral Control	.641	-9.50 [a] (8.38)	9 Culture	-12.86 [b]	-.155**	-.257**	-.206**	-.019	-.138**	-.256**	-.321**	-.074	1					
			10 Religion	-13.00 [b]	-.256**	-.367**	-.272**	-.139**	-.283**	-.430**	-.430**	.105*	.606**	1				
			11 Resources	-2.64 [b]	-.227**	-.351**	-.236**	-.208**	-.129*	-.203**	-.307**	-.176**	.239**	.274**	1			
Intentions	.863	5.86 [b] (1.57)	12 I will	5.87 [a]	.193**	.308**	.392**	.215**	.270**	.298**	.194**	.135*	-.055	-.135**	-.255**	1		
			13 I intend	5.89 [a]	.319**	.341**	.355**	.238**	.259**	.388**	.252**	.201**	-.011	-.151*	-.231**	.746**	1	
			14 I have plans	5.82 [a]	.206**	.218**	.298**	.213**	.234**	.256**	.183**	.175**	.036	-.047	-.144**	.612**	.683**	1

**=p<0.05 level, **=p<0.01 level*

[a] *Theoretical range = -21 - 21*

[b] *Theoretical range = 1 -7*

The outcome suggests that even if the respondents have a positive attitude towards BT adoption, but the required resources that will enable adoption are lacking or inadequate, behavioral intentions could be negatively influenced as revealed in this study. This is an indication that interventions designed to motivate household heads to adopt BT may have to outline and address the required resources that are perceived to be lacking or inadequate.

8. LIMITATIONS

Theoretically, this study examined the dynamics of household heads intentions to adopt BT. It is possible that the respondents may have been biased with their responses since motivational factors on the actual behavior were excluded. Secondly, the research was conducted in only Central and Greater Accra regions of Ghana, hence the model should be tested in the other regions of Ghana to allow for generalizations. Lastly, the sample size and the sampling technique is another limitation. Selection biases may have been introduced.

9. CONCLUSIONS

This paper concludes that the use of belief-based TPB model support the prediction of intentions to adopt BT by household heads in Ghana. Attitude, subjective norms and perceived behavioral control were identified to be the determinants that influence household heads intentions to adopt BT, hence, designing interventions should be based on the dynamics indicated in this study. Furthermore, perceived behavioral control had significantly negative effect on intentions, hence, it is important to outline suitable measures to correct or control the beliefs of people. These findings could serve as a guide for policymakers to help increase the rate of the adoption of biogas technology in Ghana and other developing countries.

The study outcomes lead to the following interventions:

- Respected persons in local communities, using different ethnic dialects, should lead public education and awareness creation, highlighting the benefits of biogas technology;
- Government should subsidize the cost of biogas plant installations, especially for those who cannot bear the full investment cost so as to promote its adoption rate, and consequently deal with lack of or inadequate resources.

CONSENT

As per international standard informed and written participant consent has been collected and preserved by the authors.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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