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# Mediating Role of Leadership-led Change in Adoption of Waste-to-Energy in Nigeria

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## Cover Page Footnote

LEADERSHIP-LED CHANGE AND WTE ADOPTION IN NIGERIA

**EDITORIAL NOTE**

The world is on fire as new signals of the escalating climate change and dawning catastrophe proliferate. Organizations and societies need to find innovative solutions fast in addressing this slowly evolving crisis. The need is most urgent in many developing countries which are resource poor, lack education, and are often stymied by old fashioned policies to respond to this crisis. At the same time many of these countries are the worst hit by climate change. In this article, the authors examine a small but potentially innovative way to address the crisis. They introduce waste-to-energy (WtE) solutions that address two challenges simultaneously: the dependency on carbon-based energy, and increased pollution. The authors examine in particular how leadership behaviors and related attitude changes mediate the level of WtE adoption. The study also advances our understanding of the use of theory of reasoned action in explaining specific adoption behaviors.

# Mediating Role of Leadership-led Change in Adoption of Waste-to-Energy in Nigeria

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**ABSTRACT**

The use of renewable energy has increased in the past several years. Innovative forms of sustainable alternative energy production, such as solar and wind, are well-recognized energy sources. This paper reviews waste-to-energy (WtE), an innovative and evolving form of renewable energy, and its possible adoption in Nigeria to address this nation's energy crisis and pollution problem. The theoretical framework of this paper draws from the theory of reasoned action (TRA) and the leadership-led change framework to consider the role of leaders and their influence to adopt WtE. Four factors act as antecedents to the formation of attitudes and subjective norms about WtE, which then affect intentions to adopt WtE. Intentions then become a predictor of behavior for adopting WtE. Through this framework, we examine the predicted potential for WtE as a solution for energy and pollution issues in Nigeria. We modeled leadership-led change as a mediator in the relationship between attitude and intention to adopt WtE in Nigeria. Our results show that leadership-led change partially mediates the attitude–intention relationship in the adoption of WtE. This paper makes two contributions: First, we offer an empirical account of Nigerian leaders' intention to adopt WtE as a solution for its energy and environmental problems; and second, we offer an extended TRA model that incorporates a leadership-led change framework.

## SYNOPSIS

### Purpose

The purpose of this study is to develop an understanding of the influence of leaders in Nigeria related to the decision to use waste-to-energy (WtE), a form of renewable energy (RE), as a solution to the country's energy needs and environmental issues.

### Problem of Practice

Antiquated and inadequate power generation in Nigeria hinders its economic growth and quality of life. This power generation problem contributes to the adoption of alternative sources of energy that create large amounts of pollution and hazardous waste, further exacerbate environmental problems, and create serious health concerns for individuals.

WtE can serve as a viable solution to both energy and environmental problems; however, it is not being adopted on any appreciable scale. To examine this conundrum, we examine the role of leaders and their influence in the adoption of WtE. We first study the role of attitudes and social norms in leaders' behavioral intentions to adopt WtE. We then consider the possible mediating role of leaders' ability to effect change in addressing energy and environmental concerns. Understanding leaders' attitudes and intentions toward the adoption of WtE, as well as their ability to lead change culminating in its adoption, may shed light on this lack of action in the face of major environmental problems.

Fundamentally, this study examined the research question: What role does leadership play in influencing the adoption of WtE as a plausible energy and environmental solution in Nigeria?

### Results

Nigerian leaders working in the public and private sectors reported having general knowledge of RE, specifically WtE, and confirmed the serious nature of energy and pollution concerns in Nigeria. Analysis of leaders' attitudes and intentions showed that leaders with more positive attitudes toward WtE had stronger intentions to implement WtE. Subjective norms, meaning the influence of colleagues and other leaders, did not have a significant influence on these leaders' adoption of a renewable energy, such as WtE. On the contrary, the leaders' responses indicated that they did not look to external sources for affirmation of their actions.

In addition, the manner by which Nigerian leaders effect change of intentions in the process of adopting WtE proved to be revealing: Measures of the three $A$'s (i.e., acceptance, authority, and ability), also known as the leadership-led change framework, indicated that the leaders were accepting of WtE technology and had the ability to lead in this change effort. However, results indicated only a weak expression of authority to influence the intention to change. This lack of strong authority to lead change may provide some insight into what has seemed to be an intractable problem, meriting further investigation. Among the factors contributing to this finding may be culture, politics, and underlying social mores.

### Conclusions

Adopting RE technologies, such as WtE, would be a pivotal step in resolving Nigeria's energy resource inadequacies and environmental problems and would improve the welfare of the country. In the final analysis, the likelihood of WtE adoption resides with the leaders of the country. This study combined the frameworks of the theory of reasoned action and leadership-led change to assess the attitudes and intentions of Nigerian leaders regarding the adoption of WtE, as well as their role in influencing the change space to adopt WtE as a plausible solution. Leaders exhibited positive attitudes about WtE, leading to expressions of a positive intention to adopt. However, we believe that positive attitudes and intentions are a necessary but insufficient component of what is needed to energize change. The intersection of the three A's of the leadership-led change framework appear to provide what may be the "special sauce" required for a successful effort to adopt WtE. The change space created by an intersection of leaders' acceptance of WtE, their authority/accountability to drive such a project, and their ability to bring all the pieces together to make such a project happen was evident but limited. Additional questions for future research could look specifically at the factors or issues that contribute to this sense of insufficient authority and the failure to create an effective change-space for successful WtE adoption.

### Practical Relevance

WtE appears to be a viable solution to help address the energy needs and environmental issues in developing countries like Nigeria, but there is limited WtE development. Leaders can serve as catalysts for change that leads to the adoption of WtE. To effect this change mindset, WtE advocates should motivate leaders by spreading information on the benefits of WtE. Companies specializing in WtE should promote and support the efforts of both advocates and leaders by demonstrating the viability of WtE to address Nigeria's energy and pollution concerns. Promoting WtE to leaders and to the citizenry and educating them on the benefits of WtE can further cultivate positive attitudes toward WtE. With a broader acceptance of WtE, this approach may also address the lack of authority that leaders have expressed, allowing them to step up and use the broader support to adopt WtE. Once the positive mindset is established, WtE organizations should focus on connecting leaders, organizations, and individuals to make this change.

## INTRODUCTION

A key factor contributing to the wellbeing and prosperity of a country is secure and stable access to energy. Availability of energy has a tremendous effect on a country's growth in several key areas, including the economy, education, commerce, healthcare, and transportation, and on efforts to tackle the problems associated with poverty (Jumbe, 2004; Maji, 2015; Mozumder & Marathe, 2007). Without energy infrastructure, modern economic and technological development cannot be realized, as witnessed in many parts of the developing world (Pollmann et al., 2014). Nigeria, the focus of this study, suffers from a crippling energy shortage. According to a report by the U.S. Department of Energy, "the electrification rate in Nigeria is estimated at 41%—leaving approximately 100 million people in Nigeria without access to electricity" (U.S. Department of Energy, 2015: 2).

This lack of reliable power creates additional chronic environmental and related health issues. For example, when standard electricity is unavailable, residents use other methods to generate energy—most commonly, running diesel-powered generators that cause severe pollution. Over time, concern about the related environmental hazards and other issues have mounted because of their health implications (Howarth & Norgaard, 1995). As a result, Nigeria ranks near the top globally for the worst air quality. The 2017 Robinson Country Intelligence Index (RCII) ranked Nigeria at 120, among 199 countries, with respect to air pollution and at 111 for exposure to household air pollution (RCII, 2017).

Other typical factors that contribute to the complexity and magnitude of addressing the energy crises include poor governance and a lack of transport infrastructure. Nigeria suffers from both. According to the RCII, poor governance may manifest in a variety of ways, including political instability and incidences of violence and terrorism, poor and inadequate regulations and regulatory compliance, rejection or deval-uing of the rule of law, and high levels of corruption.

The lead author of this project has extensive experience in renewable energies and WtE and has more than 25 years of hands-on field experience in Nigeria. First-hand observation reveals that, despite the acknowledged chronic need to address the energy challenge, any development remains frustrated by a myriad of constraints, most frequently attributed to a leadership failure (Collier, 2007).

The purpose of this study was to examine how leaders affect the adoption of WtE in Nigeria. We asked a group of leaders representing a cross-section of leadership roles their views on renewable energy and WtE. The theory of reasoned action (Fishbein & Ajzen, 1975), coupled with a leadership-led change model proposed by Andrews et al. (2010), served as our theoretical framework. With our work, we expand on the research of Moghadam et al. (2016) on the acceptance of WtE in the United States.

## LITERATURE REVIEW

### Energy Challenges

Developing countries typically lag far behind industrialized nations in terms of energy infrastructure, with African nations being a case in point. For example, only two in five Africans have access to a reliable supply of electricity throughout the day (Parke, 2016). Inadequate supply leads to higher electricity prices and operating costs (Foster, 2008). As Akuru and Okoro (2014) note, market distortions caused by price distortion, a poor regulatory environment, and inadequate infrastructure are a few characteristics that explain the problems with the energy market in Nigeria. Additional factors that may contribute to energy crises in developing countries include scarcity of capital and poor policymaking; energy crises are persistent in other developing countries that also boast abundant natural resources (*The Economist*, 2010). Even if they have access to a high endowment of natural resources, these developing countries are unable to generate sufficient energy because of poor policymaking (Egugbo, 2020).

Likewise, a strong link exists between access to energy and economic development. Energy consumption has been found to be causally related to gross national product (GNP) in several developing country studies, including in studies of Nigeria (Maji, 2015), Bangladesh (Mozumder & Marathe, 2007), China (Shiu & Lam, 2004), and Malawi (Jumbe, 2004). Similarly, energy infrastructure may affect the economy by increasing efficiency to reduce unproductive household costs and by improving hygiene and health (Agénor, 2009). Access to modern energy options like electricity raises employment in the formal and informal sector activities, and it raises worker productivity in value-adding processes (Dinkelman, 2011; Karekezi et al., 2012).

However, a conventional energy supply is driven by land and natural resource use, and the conversion of these natural resources into usable energy can neg-atively affect the environment, both locally and globally (Pachauri et al., 2013). Consequently, the past decade has seen increased concern about the sustainability of energy resources. Negative effects related to fossil fuel use are observed at all levels of society (locally, regionally, and globally), producing pollution and threatening global stability (Kothari et al., 2010). In terms of scalability and net production, the potential of RE has been deemed low because, among other issues, it does not produce as much energy as nuclear power generation (Kessides & Wade, 2011; Stehlík, 2009). In addition, there has been low public interest in undertaking sophisticated waste management methods (Achillas et al., 2011). Therefore, despite the various technologies available for waste valorization, a process for reusing, recycling and composting of waste materials and converting them into a source of energy, a large number of issues remain unaddressed (Stehlík, 2009).

### Renewable Energy and WtE

Renewable resource technology is defined as an energy source technology that uses a renewable or natural sources (e.g., solar energy, wind energy, bioenergy)—rather than fossil fuels—for energy production (Kozloff, 1994). RE emits very little pollution, making it a favorable technology for energy production that addresses environmental concerns (Osterhus, 1997)

Despite increasing interest in RE and waste management, energy companies have met with limited success in substituting RE for conventional energy sources. As of 2017, RE technologies accounted for 25.08% of the global production of (*Our World in Data*, 2022).

WtE is a unique form of RE that uses waste to produce sustainable energy while simultaneously reducing mismanaged waste (Achillas et al., 2011). A possible explanation for the limited use of RE, and specifically of WtE, is the concern that constraints on the energy output from RE may lead to a failure to achieve high rates of productivity. For example, a WtE-spe-cific perception is that the constant stream of waste needed for the WtE option to be sustained is inadequate (Alexander, 2016; Kessides & Wade, 2011). However, the reality is that increasing population levels, booming economies, rapid urbanization, and a rise in community living standards have greatly accelerated the municipal solid waste generation rate in developing countries (Minghua et al., 2009). The problem is that this increase in waste production is coupled with unreliable access to electricity, which is leading to the burning of waste materials and an increase in toxic fumes that results in respiratory diseases (Bruce et al., 2000). According to World Energy Outlook estimates, more than 2.7 billion people—38% of the world's population—rely on traditional solid biomass for cooking (International Energy Agency, 2016). They typically use inefficient stoves or open fires in poorly ventilated spaces, leading to serious health risks, such as lung and heart disease (Bruce et al., 2000; Rao et al., 2011; WHO, 2009).

Crippling power shortages are a major source of these problems in developing countries. In 2016, an estimated 1.2 billion people—16% of the world's population—lived without access to electricity (International Energy Agency, 2016). World in Data (2022) reported that 578 million people were without electricity in Africa in 2016. Moreover, the disparity between urban and rural populations is striking. The African urban electrification rate averaged 78.15% in 2016, while the rural electrification rate averaged only 27.72%. According to World Bank estimates, around 61% of people lived in sparsely populated rural areas in 2016 (The World Bank, 2016). Thus, access to energy, and especially electricity, remains a major issue for most of the African continent.

In Nigeria, sustainable energy creation is needed to meet critical electrical demands, and only powerful leadership and efficient policies can accomplish this goal. In a promising sign for RE adoption, President Muhammadu Buhari of Nigeria demonstrated both concern for and knowledge about RE as a source for addressing cli-

mate change and meeting energy demand (*The Guardian Nigeria*, 2016).

## Theory of Reasoned Action (TRA)

TRA (Fishbein & Ajzen, 1975) has been used extensively as a model for predicting human behavior in a myriad of contexts. Two studies are of particular interest for our context. First, Mishra et al. (2014) used TRA to investigate behaviors leading to the adoption of green information technology (GIT) by IT practitioners for information and communication technologies. They found that when IT professionals had positive intentions toward GIT, they positively affected their choices and use of information and communication technologies (ICTs) in their work. Second, Bang et al. (2000) used a partial TRA model to understand consumers' attitudes and behavioral intentions regarding RE and their intention to pay more to consume RE. They found that environmental concern and knowledge of RE were important components for the formation of beliefs and, to some extent, for consumers' willingness to pay more for RE. This study was situated in the United States. Although the spectrum of challenges as outlined for Nigeria is quite different, the study's focus on RE and on predicting human behavior aligns with our decision to use TRA for our study.

In both studies, the intention to perform the behavior is influenced by attitudes toward behavioral intentions and, subsequently, toward the behavior itself. In addition, the attitudes of others who are important to the decision maker, although not included in the Bang et al. (2010) study, may assert social pressures and influence the behavioral intention as well. In the model, this aspect of influence is called subjective norms. Figure 1 presents the full TRA model.

**Figure 1: Theory of Reasoned Action (TRA), by Fishbein and Ajzen (1975)**
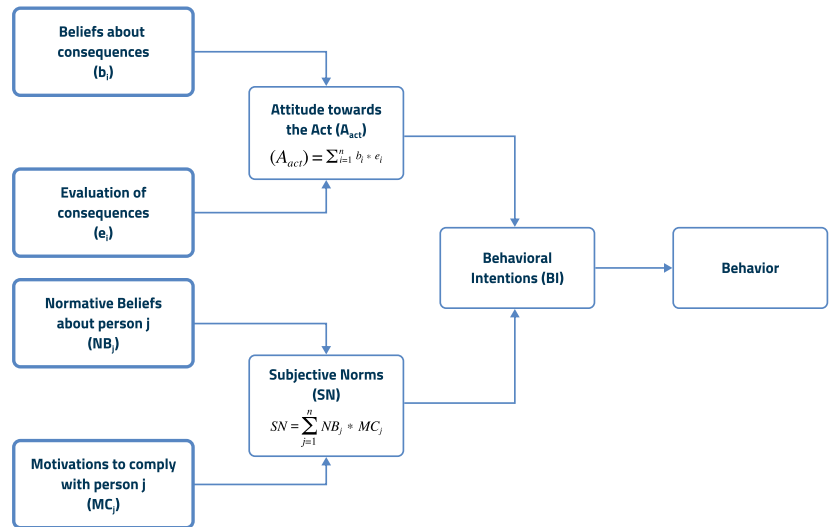


Our research extends these past studies to consider not just the attitudes, intentions, and behaviors related to the adoption of WtE but also the role of the leader and how the leader may influence the adoption of WtE. In the context of our research, TRA helps us to understand the behavior of Nigerian leaders based on their pre-existing attitudes. Like other individuals, Nigerian leaders tend to behave with respect to the outcomes they expect (Madden et al., 1992). We suggest that the stronger the positive beliefs regarding RE—and specifically WtE—the greater the likelihood they will demonstrate a positive behavioral intention to adopt WtE, ultimately leading to its adoption.

However, TRA by itself is likely to be insufficient to point the way to a successful adoption of WtE. In the next section, we explain the leadership-led change framework (Andrews et al., 2010) and how it might work in tandem with TRA to assess the chances of successful adoption of WtE.

## Change Leadership and Leadership-Led Change

Change seldom happens in a void or on its own. Rather, problems arise that provide motivation for the change, so contextual issues reflected in the internal and external settings always must be considered.[1] The common challenge is to identify and create the space to effect the needed change in a success way. An inability to create or expand the change space results in a failure to change. In turn, this inertia may relegate the respective entity (e.g., organization, community, or country) to lower its development trajectory paths, as evidenced by weak growth and limited opportunities to grow.

Drawing from the extant change literature and building on their own work (e.g., Andrews, 2004; Andrews, 2008), Andrews et al. (2010) propose a basic change space model.[2] The space comprises three factors that, when integrated, influence the ca-

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[1] The change focus for this study is at the country/societal level. Many studies report high failure rates, as well as a mix of other less-than-intended outcomes. Recent studies include Gilley (2005), Waclawski (2002), Washington and Hacker (2005), and Cartwright and Schoenberg (2006). See Andrews et al. (2010) for a more detailed discussion of this stream of literature.

[2] For change literature, see Armenakis, Harris, and Mossholder (1993); Buchanan et al. (2005); Cinite, Duxbury, and Higgins (2009); Kotter (1995); Lewin (1951); Senge et al. (1999); Van de Ven and Poole (1995); Walker et al. (2007); and Weick and Quinn (1999).

pacity to successfully effect change. The three factors are: Acceptance, Authority (and accountability) and Ability (Andrews 2004, 2008). (See Figure 2.) Change requires acceptance by the leaders and, by extension, other parties that may be affected for a need of change. Change also requires that leaders have both the authority to act and the accountability that influences them to act on their beliefs and commitments. Finally, for change to be enacted, the necessary abilities or resources must be available. These abilities or resources are broad in nature, including fiscal, human, and informational resources. The change space emerges at the intersection of the three *A*'s.

Most leadership scholars make a direct connection between leadership and change: Burns (1978) posits that leadership is most prominent in the change context; Yukl (2002: 273) asserts that "[change] is the essence of leadership and everything else is secondary." Andrews et al. (2010) provide a detailed discussion of the disparate leadership literature. After they distill the essence of this literature, they shift their focus from leaders to a functionally driven approach to leadership, combined with the change space model. The question that Andrews et al. (2010) then ask is this: "What does the leader do in the change process?" (2010: 13).

Although the change space model may appear simplistic, its theoretical foundation is derived from many different theories on the topics of change leadership and leadership-led change. The three primary theoretical approaches are transformational, transactional, and relational leadership models. The latter refers to connective, collaborative, and network theories, in particular. In the interest of space, Andrews et al. (2010) provide a detailed discussion of these three main streams and elaborate on how they contribute to our understanding of leadership in general, as well as, more specifically, how it contributes to change when it builds change space. The change space is where leaders have and foster acceptance for change; have and grant authority to change; and have and introduce or make available, the ability to enact change. This combination is what Andrews et al. (2010) call leadership-led change. They note that the strong presence of one factor, such as acceptance, cannot result in effective change when the other two factors are weak. Alternatively, the convergence of the three factors creates change space that allows for (or constrains) the desired action. For this study, the desired action is the adoption of WtE.

The development of the leadership-led change model is not limited to a theoretical exploration but serves as a lens through which Andrews et al. (2010) con-

ducted a real-world engagement focused on stimulating development through leadership promotion. Their study examined leadership in change processes in an empirical, qualitative study involving 14 capacity development interventions in 8 developing countries.

The main focus germane to our study is the role that leadership plays in effecting change. Therefore, we incorporated the Andrews et al. (2010) leadership-led change framework to obtain insight into what our lead author was experiencing in real time: a widely acknowledged, highly consequential problem of an inadequate energy grid, coupled with a failure to successfully respond to the situation. To this end, we asked recognized leaders, based on their functional roles and their experience, to assess their belief commitment to adopting WtE and their self-reported contribution to the three *A*'s. This study examined the research question: What role does leadership play in influencing the adoption of WtE as a plausible energy and environmental solution in Nigeria?
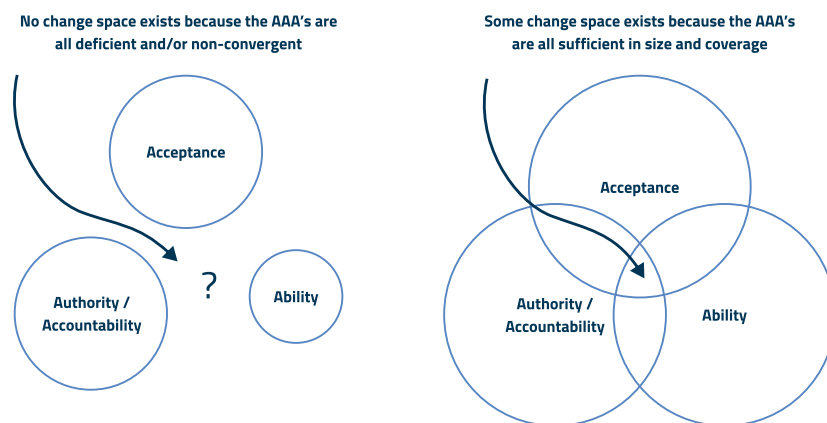
## THEORETICAL FRAMEWORK AND HYPOTHESES

We illustrate our conceptual model for predicting the adoption of WtE in Nigeria in Figure 3. The model combines the TRA Leadership-led change model and the three *A*'s.
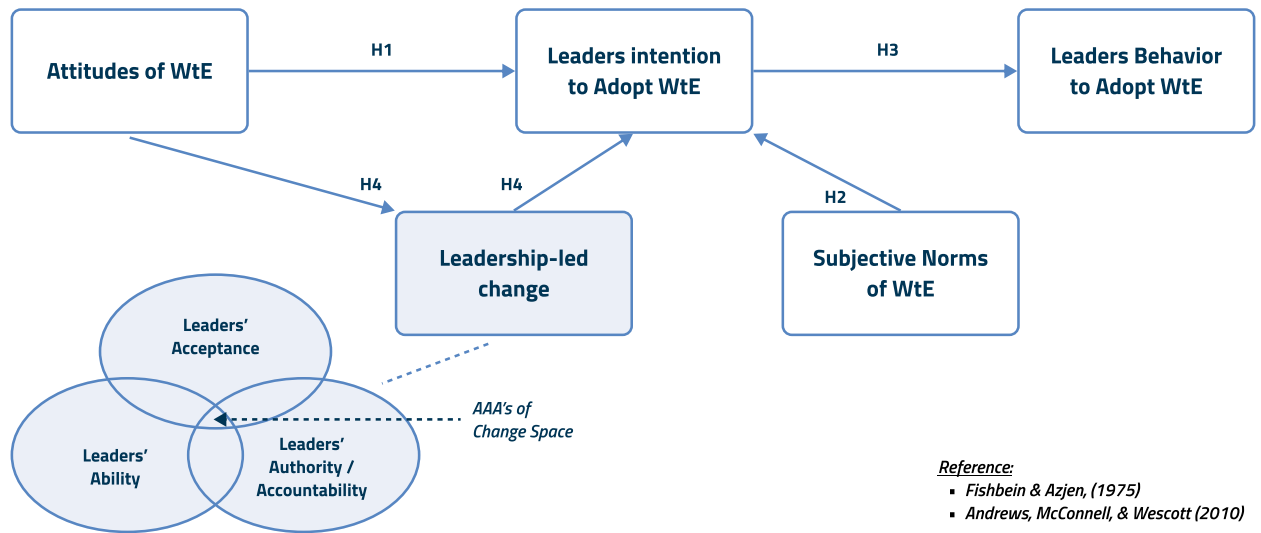
### Direct Effects Hypotheses

An intention to adopt is necessary for widespread implementation of any innovative technology, but appropriate policy by country leaders also is necessary. TRA suggests that people contemplate the consequences of new behaviors before implementing them, and individuals choose to use the behaviors that they relate to desirable outcomes. They argue that behavioral intent is derived from two factors: (1) attitude toward the behavior, and (2) subjective norms. The attitude can be any distinguishable part of a person's realm, including behavior, while subjective

**Figure 2: Leadership AAA Model Creates Change Space**



No change space exists because the AAA's are all deficient and/or non-convergent

Acceptance

Authority / Accountability    ?    Ability

Some change space exists because the AAA's are all sufficient in size and coverage

Acceptance

Authority / Accountability    Ability

**Figure 3: Conceptual Model: TRA Leadership-led Change Model**



Reference:
- Fishbein & Azjen, (1975)
- Andrews, McConnell, & Wescott (2010)

norms represent an individual's perception of how people think they should (or should not) perform a particular behavior (Fishbein & Ajzen, 1975).

Attitude is the first construct that affects intention, which then leads to a behavior. Attitudes consist of beliefs and evaluations. Applied to the context of this study and to understand why people hold a certain attitude about WtE and its adoption, we need to assess their salient beliefs about WtE. Armitage et al. (1999) found that, when most respondents believed an outcome to be favorable, they had positive attitudes, thus showing a positive correlation between belief and attitude. When people have experience or prior knowledge about energy creation and sustainable energy, the result is a positive or favorable belief about them, leading to positive attitudes about WtE. Consequently, leaders who have more positive beliefs about adopting WtE, developed through their prior beliefs and evaluations, will have a more positive attitude toward WtE. Therefore, we offer the following hypothesis:

**H1: Leaders with positive attitudes about WtE will have a positive intention to adopt WtE.**

According to Fishbein and Ajzen (1975), the intention of an individual also depends partially on subjective norms, which are composed of normative beliefs and a motivation to comply. Previous literature also shows that motivation to comply can add some insight to subjective norms (Budd et al., 1984; Montaño et al., 1997). The relationship between subjective norms and behavioral intentions has been thoroughly established in the literature (Chan & Lau, 2001; Gusti et al., 2015; Mahmud & Osman, 2010). Based on this proven relationship, we propose the following hypothesis:

**H2: Leaders with positive subjective norms about WtE will have a positive intention to adopt WtE.**

Intention is not a complete predictor of behavior, but it is a determination to act in a certain way. Intention describes an attitude–behavior relationship, as explained by Bagozzi et al. (1990), that can also be influenced by the level of effort required to exercise the behavior; that is, not all intention leads to a behavior. However, previous studies have examined behav-

ioral intentions and their predictability of behavior with high accuracy (Bang et al., 2000; Mishra et al., 2014; Ramayah et al., 2010). The intention–behavior relationship also is critical to this research because the purpose of this study was to understand what can lead to the adoption of WtE. Therefore, this relationship forms the basis of the third hypothesis:

**H3: Leaders who have positive intentions to adopt WtE will positively affect leaders' behaviors to adopt WtE.**

**Mediating Hypothesis**

Leadership plays an important role in the adoption of WtE in Nigeria. Therefore, we adopted the leadership-led change three *A*'s model (Andrews et al., 2010) to examine whether and to what extent leadership may affect attitudes toward WtE and intention to adopt WtE. If such a relationship does exist, our expectations are that leaders who have stronger attitudes toward energy creation and environmental issues will have a higher intention to adopt WtE and that effective managerial action has the potential to directly improve adoption of sustainable practices and outcomes (Moghadam et al., 2016; Wang et al., 2014). Moreover, the "change space" may

be affected by the beliefs of the leaders in themselves concerning the three *A*'s of change, which would mediate the attitudes and the resulting behavioral intentions to adopt WtE. Previous literature on leadership as a mediating construct to a behavior construct supports this research inquiry (Yousef, 2000). Such findings provide the basis for our fourth hypothesis:

***H4: Leadership-led change positively mediates the relationship between leaders' attitudes about WtE and their intention to adopt WtE.***

See Figure 3 indicating proposed hypotheses.

## METHODOLOGY

An online survey was conducted of Nigerians in leadership roles or positions. For this study, we define leadership in terms of individuals in an executive role who hold senior positions in government or the private sector and who have eight years or more of work experience (this definition is similar to that of Andrews et al. (2010)). More than 750 leaders from both the public and the private sectors were invited to participate; all participants held a bachelor's degree or higher level of education. Governmental leaders included respondents with such titles as directors, deputy directors, general managers, project managers, legislators, ministers, advisors, and senior military members. Leaders from the private sector included business owners, CEOs, board members, and tribal and religious leaders. We determined the target sample size using an a priori sampling methodology with power of 0.9 and effect size of 0.3 (Soper, 2017), which necessitated a sample size of 188 for the study.

We administered a five-point Likert scale survey, with possible selections ranging from "strongly disagree" to "strongly agree" (as used in Mishra et al. (2014)), along with other categorical and demographic questions. (See our survey instrument in Appendix A.) We based the survey on TRA (Fishbein & Ajzen, 1975)

and on the leadership-led change framework (three *A*'s) of Andrews et al. (2010). The latter study had been conducted in the form of qualitative interviews. For our study, we tried to create questions that would measure the three *A*'s. As such, the effort is preliminary and exploratory in nature. Our survey gathered data on the following leader-related constructs relative to WtE: attitude (comprising beliefs and evaluations), subjective norms (comprising normative beliefs and motivation to comply), WtE intention, WtE behavior, and the three *A*'s of change space (i.e., acceptance, authority/accountability, and ability) to adopt WtE.

### Data Collection and Cleaning

In total, 239 surveys were collected online over a five-week period. We excluded 14 respondents who were ineligible for the study because they didn't meet the required parameters: 1) 18 years of age and older, 2) Nigerian citizenship, and 3) a minimum of eight years of work experience. We excluded another 41 respondents from the sample set because they completed the survey in less than three minutes (the minimum time needed, determined through a pilot survey) or did not complete the full questionnaire. The resulting sample was 184 completed surveys, representing a 25% response rate. Although a larger sample is always preferred, our sample represents a heterogenous mix from an elite population; respondents came from all regions of Nigeria, generally clustered in cities with one million and greater in population and many sectors.

### Structural Equation Modeling (SEM)

We used structural equation modeling (SEM) in this study because of the method's ability to facilitate exploration of relationships between multiple latent (i.e., unobservable) and observable variables. Because of the nature of this study, partial least squares (PLS)-SEM was judged most suitable for reasons enumerated in Hair et al. (2018); these reasons include our extension of current theory rather than confirmation of theory, our testing of

a theoretical framework from a prediction perspective, the model's superiority to regression analysis when assessing mediation, and its ability to measure formative latent constructs and non-normal data.

Because we used PLS-SEM as the analysis method for the study, we deployed a measurement model prior to analysis so that meaning could be derived from the results of the overall analysis (Bagozzi, 1981). The principal aim of PLS-SEM is maximization of the explained variance in a set of data through the definition of endogenous constructs (Hulland, 1999).

Figure 4 shows our research model comprising five constructs: attitudes, subjective norms, intention, and behavior, with leadership-led change as a mediating construct. Each of these constructs was assumed to be formative because the corresponding indicators were not interchangeable and because removing an indicator would change the construct meaning and direction of causality (Jarvis et al., 2003).

Formative constructs are composites of several different aspects, and the indicators are not necessarily correlated to each other (Diamantopoulos & Winklhofer, 2001). Diamantopoulos and Siguaw (2006) further argue that no dimensionality or reliability tests are performed on formative indicators because factorial unity in factor analysis and internal consistency are not relevant. Andreev et al. (2009) conclude that construct reliability of formative data should be performed by multicollinearity and a test of indicator validity (path coefficients significance) (Hair et al., 2018; Petter et al., 2007). In line with this literature, we conducted two tests to confirm the reliability of the formative constructs. First, we ran a variance inflation factor (VIF) test to check the multicollinearity (see Appendix B, Tables 1 and 2); and second, we ran a confirmatory tetrad analysis (CTA) to test the fit of PSL-SEM. We conducted the CTA with subsamples of 5,000, and performed a two-tailed test at the 5% significance level. All p-values were

Figure 4: Research Model
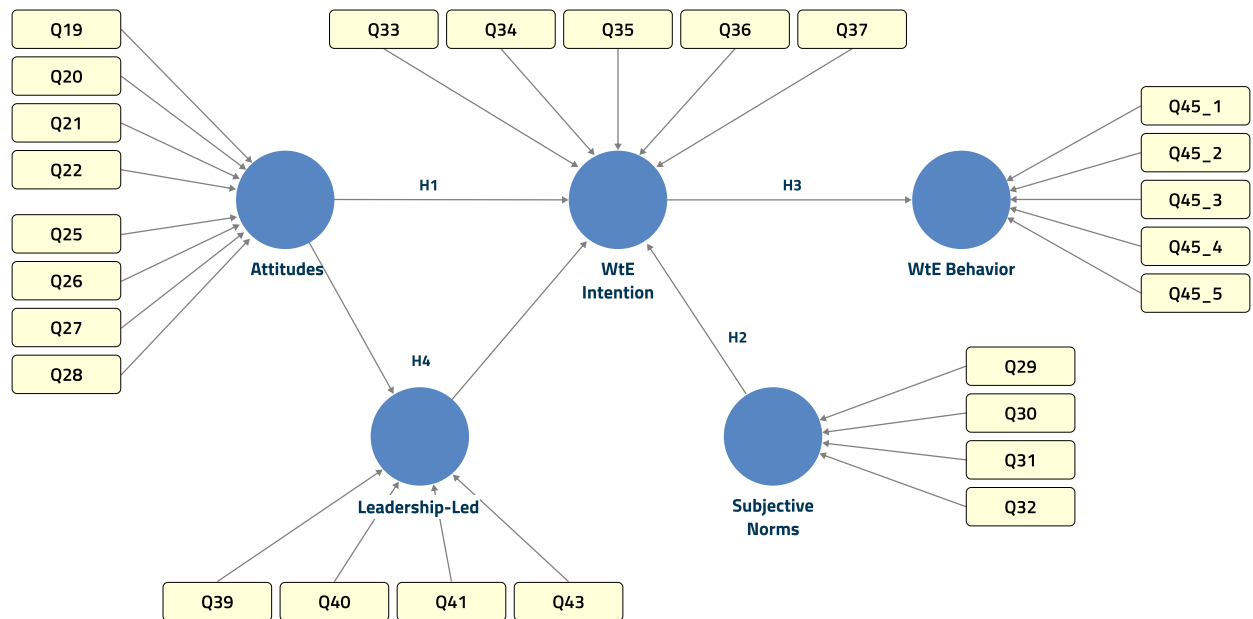
significant, providing support for a formative measurement model.

Finally, we used Stone-Geisser's $Q^2$ value to measure the model's predictive relevance (Hair et al., 2018). In this study, we calculated blindfolding in PLS-SEM, and $Q^2$ values resulted from medium intention ($Q^2 = 0.395$), medium leadership-led change, at $Q^2 = 0.224$, and small behavior at 0.05. $Q^2$ values above zero indicate that the model has predictive relevance. (See Appendix B, Table 3.)

## RESULTS

### Descriptive Statistics

From the 239 people who initially participated in the leadership WtE online survey, the final sample size was 184 respondents after data cleaning, as previously described. IThe sample was 67.0% male, and respondents' average age was 46.84 years. All regions of Nigeria were represented, and most respondents (84.2%) lived in cities with a population of one million or more. Our sample included well educated respondents, with 96.2% reporting

that they hold an undergraduate degree or higher; the majority also completed a graduate degree or higher (82.1%). In terms of economic sectors, government was the most commonly reported area of employment (60%), and the private sector was second, at 36%. In addition, some respondents said that they function in more than one sector. Percentiles of time in which a respondent had held a leadership position (in years) were evenly distributed across four ranges: 6 to 10 years; 11 to 15 years; 16 to 20 years; and more than 20 years; the percentiles ranged from 19.6% to 22.8%. (See Table 4 in Appendix B for detailed descriptive statistics.)

With respect to RE in general and WtE in particular, 92.4% reported at least some knowledge of RE, and 89.1% reported at least some familiarity with WtE. For RE, the sample mean was almost equivalent to "very knowledgeable" (M = 3.61, SD = 0.87), with 40.2% reporting themselves to be "very knowledgeable" and 15.2% "extremely knowledgeable." For WtE, 47.8% were "very familiar" and 11.4% "extremely familiar."

### PLS-SEM Results

Based on the study hypotheses, we tested the strength and direction of the following effects: attitudes on intention to adopt WtE (H1); subjective norms on intention to adopt WtE (H2); intention to adopt on actual behavior (adoption of WtE) (H3); and the leaders' ability to create a leadership-led change space that would play a role in the relationship between attitudes and intention to adopt WtE (H4). Figure 5 shows the PLS-SEM structural model for direct effects, with Beta and p-Values. Figure 6 shows the PLS-SEM structural model for mediation, with Beta and p-Values.

Fitting the model to the survey data yielded strong support (p < 0.001) for Hypotheses 1 and 3 (see Table 5 in Appendix B).

The respondents expressed positive attitudes about WtE and a strong, positive intention to adopt WtE. Surprisingly, our findings show very weak support (p < 0.1) for Hypothesis 2. This result suggests that the respondents' intentions to adopt WtE were not influenced by subjective norms. A possible explanation for this result is that the study participants hold leadership

**Figure 5: PLS-SEM Structural Model Direct Effects, with Beta and p-Values**
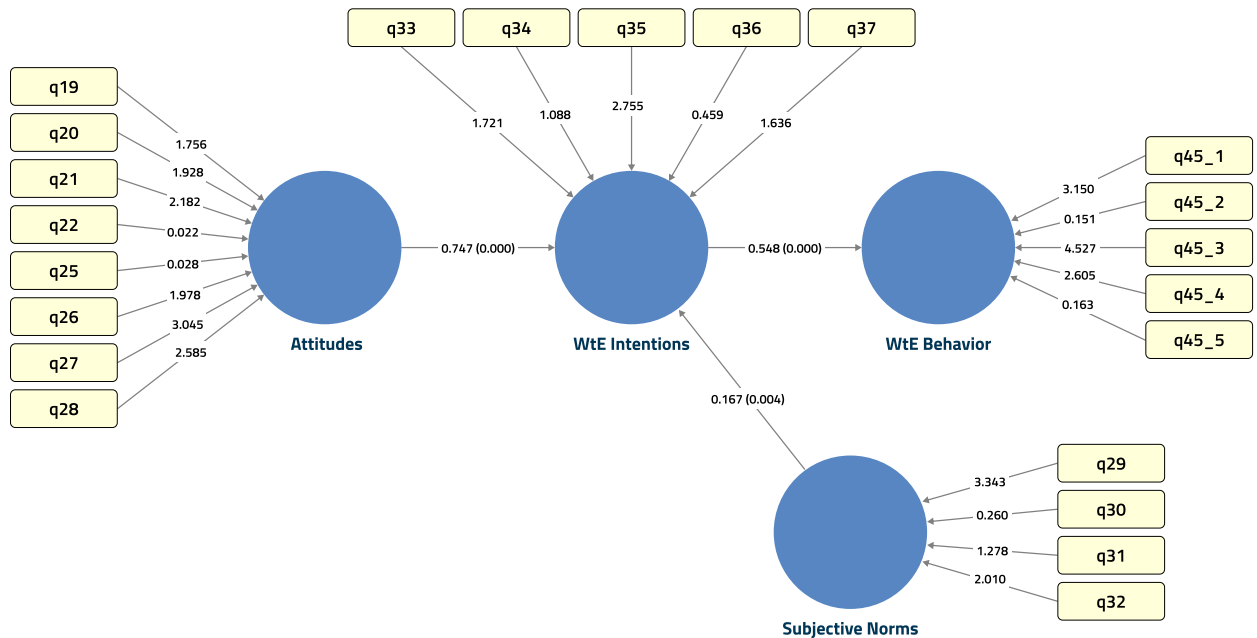


positions, and their experience, education, or relatively high positions in their respective hierarchies may cause them to be less easily influenced by the opinions of their colleagues. Previous research supports this interpretation; subjects in a study by Bagozzi and Yi (1989) reported minimal influence from subjective norms, resulting in low levels of social influence. An alternative explanation may be that, because of their leadership position, participants did not wish to convey that they were or could be influenced by others.

We also found strong support (p-value <.001) for Hypothesis 3: Positive intentions to adopt WtE affect participants' behaviors. However, we note that we were not able to actually observe real behaviors; instead, we asked participants to indicate the extent of their agreement or disagreement with the statements that they would do the described behaviors. Finally, Hypothesis 4 was constructed to examine whether the leadership-led three *A*'s of change space proposed by Andrews et al. (2010) had a mediating effect on the relationship between the attitudes of leaders and their intention to adopt WtE. The mediation effect between leaders' attitudes and WtE intention was statically significant, with p-value < 0.001. This measure examines the relationship between the dependent and independent variable and measures the relationship between the two variables, including the mediation construct (Helm et al., 2010).

Because this study had only 184 responses, we also used the work of Preacher and Hays (2008) to reconfirm this relationship in PLS-SEM. The bootstrapping process makes no assumptions about the shape of the variables' distributions, thus making it suitable for use in PLS-SEM which allows the sample distribution for the statistics to be applied to smaller sample sizes with more confidence (Hair et al., 2018). Preacher and Hays (2008) recommend bootstrapping over Sobel testing because bootstrapping has greater power while sustaining reasonable control over Type 1 error rate. The mediator effects results using the Preacher and Hays (2008) bootstrapping were found to be statistically significant at the 5% level for attitudes of WtE on intention to adopt WtE, with leadership-led change having a partial mediating effect. These results support our hypothesis that leadership-led change has a mediating effect on attitudes and WtE intention.

## DISCUSSION AND CONTRIBUTIONS

Nigeria, a developing country, suffers a continuous 60% shortfall in energy production (Kennedy-Darling et al., 2008), which inhibits its development and growth. Increasing reliance on RE technologies, such as WtE, would seem to be a vital step in addressing the nation's energy resource inadequacies, thus improving the welfare of Nigeria's citizens and also its economic outlook over the medium to long term (Shaaban & Petinrin, 2014). The potential for implementing these technologies logically rests with the country's leaders. Thus, this study has tried to determine why Nigeria's leaders have not pushed more strongly for adoption of RE in general and WtE in particular. When they see the critical need for clean energy, leaders can play a key role in implementing such projects.
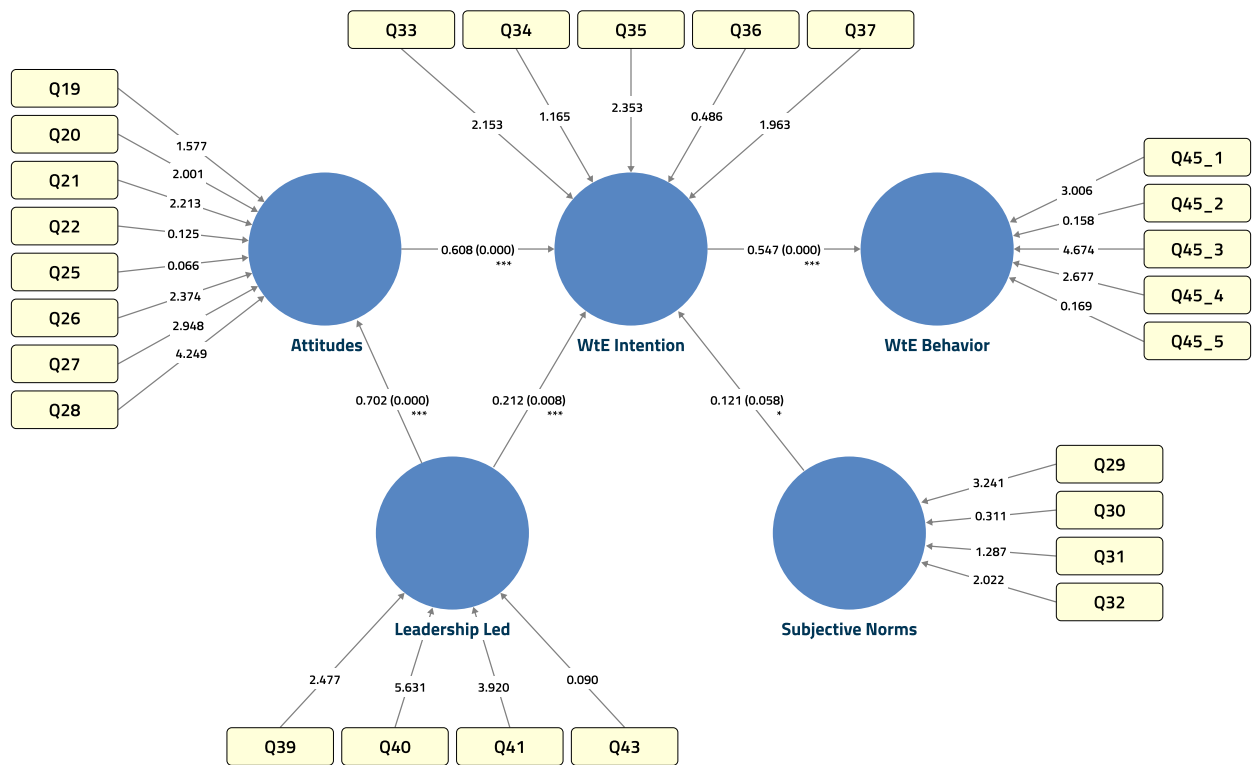
Respondents clearly indicated that they supported RE and WtE as a viable solution to address clean energy concerns, as evidenced by the support for H1 and H3 and by the additional thoughts they shared. The partial mediation result provides some insight at two levels. First, respondents assessed themselves as exhibiting leadership influence, as measured by the three *A*'s. We believe that this result demonstrates the potential efficacy of this approach in influencing change processes, consistent with Andrews et al. (2010). Building on this first insight, we suggest that the three *A*'s offer leverage to considerably expand the change space and, in doing so, to lead to the successful adoption of WtE. The practical questions should identify who can increase the magnitude of the three *A*'s and how they can do so. (See Andrews et al. (2010) for some suggestions in this regard that should be considered by vested parties in the WtE project.) The first *A*, acceptance, which is founded on a belief-based commitment to the intended change, is consistent with the support of our first hypothesis. The leaders expressed strong acceptance for WtE. They also expressed a strong *ability*—the third *A*—to influence the adoption of WtE. However, in relation to the second *A*, the respondents expressed a lack of authority or accountability. We struggle to explain this non-significant result and offer the following as a possible explanation. The respondents are individuals with high standing in their respective communities. They may have recognized that successful WtE adoption would necessarily require more than what they could achieve in their individual role; instead, effecting the adoption of WtE would require a group effort that goes beyond their boundaries of authority. Consequently, they demurred on an outright expression of authority to adopt WtE. This result also may reflect their cultural orientation as a collectivist society, which is manifested in their close, long-term commitment to their member group, but their authority may not extend naturally as a connector to other groups. This explanation supports the argument by Andrews et al. (2010) that leadership is more about groups than about individuals.

**Practical Contributions**

These findings are of value to practitioners in the fields of energy production and of RE production in general, and to Nigerian leaders in particular. The study established that attitudes toward WtE were a driver of intent to adopt, which in turn was a driver to adoption. Policy makers, political leaders, and vested parties from the private sector wanting to promote WtE in Nigeria may wish to concentrate on the factors that contribute to leader-led change—leaders' acceptance, ability, and authority in their leadership roles. Efforts could be made to ensure that Nigeria's leaders accept the technology and then serve as advocates for it through various

mechanisms, such as offering incentives to other community leaders and officials to engage, learn, and delegate authority to create a broader coalition. Initiatives to create stronger relational experiences—for example, through workshops, highly visible meetings, open conventions, and expanding leader networks—also increase acceptance to enable change, resulting in increased credibility for leaders, as well as greater intention to adopt RE, such as WtE. Likewise, leaders may increase and expand their perceived authority by creating task forces charged with WtE adoption, delegating authority to invest in WtE, and holding workshops that galvanize broader support for WtE adoption. A consortium of leaders also may serve to build authority and accountability. Leadership ability to effect such change may be enhanced through better information transparency about projects and their projected benefits; the goal for such initiatives is to amass people, information, money, and skills to advance implementation of WtE. Inspiration from outside parties—for example, where WtE already has been adopted and is successfully functioning—will increase confidence in leaders' ability to be successful.

A pragmatic suggestion for practitioners in the RE industry wanting to promote RE technology, such as WtE, is to provide leaders with information and materials that aid them in educating and changing attitudes of those within their spheres of influence. Survey respondents highlighted the importance of a leader advocating for acceptance of the technology: One said that "I will pass the knowledge I got from here on to promote the awareness of WtE." Another respondent stated: "I will help to advocate to my other fellow community leaders with no knowledge of WtE and share it with my other family members who are in a position of authority."

**Theoretical Contributions**

Unlike the study by Bang et al. (2000), which did not include subjective norms in its structural model, this study used the full TRA model of Fishbein and Ajzen (1975), and we incorporated a leadership-led change model (Andrews et al., 2010) to assess the role of leaders in relation to the attitude-to-intention-to-behavior movement. Thus, the model used in this study was an extension of previous models, was situated in a developing country, and focused on RE. The failure of subjective norms to be a significant influence on leaders' intent to adopt suggests that these leaders are not heavily influenced by other parties when formulating their behavioral intention to adopt WtE. Instead, these leaders felt sufficiently confident in their acceptance of the WtE technology and their ability to advocate for the adoption of WtE. They were not looking to external sources for affirmation of their actions, possibly in part because of their level of education and of their expertise in their roles.

Adopting the leadership-led change framework (Andrews et al., 2010) was a first attempt to operationalize the framework in a quantitative manner, which prior to this research had not been done. Leadership-led change partially mediated the direct relationship of the leaders' attitudes on their intention to adopt WtE, giving merit to further examination of this framework and the three *A*'s. However, we also note that although acceptance and ability were significant contributors to the mediated relationship, we found only a weak expression of authority to move forward with the intention to adopt. This unexpected result may suggest a disconnect between the leaders' belief in that adopting WtE is the right thing to do, their acceptance of WtE's value, their ability and willingness to serve as an advocate for WtE adoption, and, to a lesser degree, their explicit authority to effect the change. Another possible explanation is that, within the sample, the leaders may have been exceptionally well-educated and placed in high positions of authority across sectors, but a range of hierarchical levels that we weren't able to detect may have affected their self-rated authority and their willingness both to take a public lead in the adoption of WtE and to see it through. Because this study was the first attempt, to our knowledge, to measure the three *A*'s in a quantitative manner, our findings point to the merit of additional testing and development of the metrics used to measure the three *A*'s.

**Limitations and Future Research**

In this type of study, practical and theoretical limitations are inevitable. We discuss two limitations and then offer future research ideas to build on this study.

One obvious limitation was our inability to evaluate actual behavior. In practice, participant behavior would be measured by action aimed at establishing WtE in Nigeria. Observing such behavior in the context of our study was impossible, and possible avenues of future research would be a longitudinal study or a study linking present intention with future actions. Rather than actions, our study used measurement of behavior in a manner somewhat similar to the manner described in Bagozzi and Yi (1989). As proxies for behavior, we used five indicators based on Likert-type survey questions that expressed a willingness to perform the action described:

- Sign a letter of support for WtE
- Attend meeting with colleagues/leaders to support WtE adoption in Nigeria
- Show support publicly for the adoption of WtE in Nigeria
- Support allocated resources to use WtE in Nigeria
- Learn more about WtE
- Other (Please share what you would do)

Although this question constituted the study's attempt to measure behavior, we acknowledge the difficulty of directly examining the behavior of WtE adoption. Future studies might try to examine whether the intentions of the leaders participating in this study bore fruit through WtE-related actions.

Second, as noted earlier, the sample size of this study was small, and a larger sam-

ple is preferred statistically. Realistically, the broad engagement of many individuals is challenging, so future researchers may adjust the design to consider how to better study those in the leaders' circle, or they may go deeper by doing in-depth case studies examining post-hoc adoption of RE/WtE.

Subsequent studies could expand on behavior models to measure and analyze the influencing factors of WtE adoption in developing countries. This future work could provide important insights by assessing in greater depth the factors that are most salient in the theoretical context and their implications for the adoption of WtE or other renewables.

Another consideration would be to conduct in-depth interviews, which would allow for asking questions and clarifying statements to uncover ideas and information that we had neglected, and thus yielding nuances that are not captured in a survey methodology. For example, such an option could increase the understanding of leaders and potential consumers/beneficiaries of the adopted RE in building marketing strategies for WtE.

Future work also might extend the study by including a second group of "non-leaders" or "the general public" and comparing this second group's perceptions of the factors that influence WtE adoption with those of the leaders. A comparison of the two samples' assessments of the relationship between leadership-led change and its influence on WtE adoption may prove interesting and informative.

Finally, a case study designed to examine and compare the effects of two developing countries and their use of WtE may provide meaningful insights. Moreover, this approach would allow exploration of cultural differences that could also affect the factors and success of implementation, resulting in a more robust measurement of behavior of adoption in WtE.

We identify a few additional future considerations and questions for study: What factors or issues contribute to the leaders' assessment of their insufficient authority? What role might RE and WtE groups play in this process? How might leaders come together collectively to increase their authority and to lead change that influences the adoption of RE and WtE as solutions to their energy and environmental issues?

## CONCLUSION

In the survey, the respondents were asked to share their thoughts about energy and pollution concerns in Nigeria. To summarize the sentiments expressed in these comments, the most repeated words have been represented in the word cloud shown in Appendix B (see Figure 7). The different size and color of words used by participants indicates their prominence in terms of frequency—that is, the more-often repeated words have a bigger font size than others. The word cloud offers some insights into what the leaders are thinking with respect to energy and pollution concerns in Nigeria. Apart from the words Nigeria and WtE, other words that stood out included adopt, awareness, change and support. Overwhelmingly, the respondents used words that reflected the prominence of the energy problem and words reflecting a positive view of WtE technology. One leader in our study made this request: "Please continue with your research, so that Nigeria can adopt the system." Another wrote, perhaps most encouragingly, that "WtE is a world changer and from what I've learned so far, the future is brighter with WtE." Although brief, their comments provide additional nuance for how they view the possible adoption, the required change, and WtE itself.

This research illustrated how WtE could benefit countries that are suffering from both pollution and an energy crisis. Using the case of Nigeria, we found a significant relationship between the role of leadership and the adoption of WtE. We can determine from this study that leaders are willing to take action toward adopting WtE as a possible solution to the country's two problems; however, the observed behavior of adopting WtE lies outside the potential and thus the scope of this study. For now, this study has provided a path forward for practitioners by theorizing how different factors can contribute to a leader's intention to implement WtE.

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**1: What is your age?** (Filter/Control Question, must be 18 or older. If not, *Thank you message, exit survey*)

_ _ _ _ _ _ _ _

**2: Are you a Nigerian citizen?** (Filter/Control Question)

○ Yes
○ No (Thank you ve*ry much for your willingness to participate).*

**3: How many years of work experience do you have?** (If less than 8 years, *Thank you very much for your willingness to participate.*)
(Filter/Control Q's)

○ Less than 8 years.
○ 8 years or more

*[full survey begins here]*

*(Demographics)*

**4: What is your gender?** (qDemographic)

○ Male
○ Female

**5: Broadly, what is your geographic location within Nigeria?** (qDemographic)

○ East
○ West
○ North
○ South

**6: Do you live in** (qDemographic)

○ A Major Metropolitan area (population over 2,000,000 people)
○ A City (between 1,000,000 and 2,000,000)
○ A Small City (between 500,001 and 999,999)
○ A Town (between 100,000 and 499,999)
○ A Rural area (under 100,000)

**7: What is your highest education level completed?** (qDemographic)

○ Up to High School
○ High School Diploma
○ Some College
○ Undergraduate Degree
○ Graduate degree or higher

**8: Your experience as a leader is in which area (please select all that apply)** (qDemographic):

○ Government
○ Private
○ Community (for example: Pastor, Chief, Tribal, etc.)
○ Military

**9: How long have you been in a leadership role/position?** (qDemographic)**:**

○ 1 to 5 years
○ 6 to 10 years
○ 11 to 15 years
○ 16 to 20 years
○ Greater than 20 years

**10: Please indicate the number of years of experience, respectively, in the applicable sector:**

| Sector | How many years of experience do you have in each sector | How many years have you been in a leadership role |
|---|---|---|
| Government | | |
| Private | | |
| Community | | |
| Military | | |

**11: How knowledgeable are you with Renewable Energy?** (qKnowledgeRE)

1. Not at all knowledgeable
2. Not knowledgeable
3. Somewhat knowledgeable
4. Very knowledgeable
5. Extremely knowledgeable

**12: I do not have a clear understanding of Renewable Energy.** (qKnowledgeRE)

1. Strongly disagree
2. Disagree
3. Neither agree nor disagree
4. Agree
5. Strongly agree

**13: How familiar are you with Waste-to-Energy (WtE)?** (qKnowledgeWtE)

1. Not at all familiar
2. Not familiar
3. Somewhat familiar
4. Familiar
5. Very familiar

**14: I do not have a clear understanding of Waste-to-Energy (WtE).** (qWTE Knowledge-)

1. Strongly disagree
2. Disagree
3. Neither agree nor disagree
4. Agree
5. Strongly agree

**15: Please view the following Waste-to-Energy (WtE) diagrams and information prior to completing the remainder of the survey**.

WtE is a form of renewable energy that takes any type of waste and converts it into energy.



*Source: Africa Engineering New, 2014*
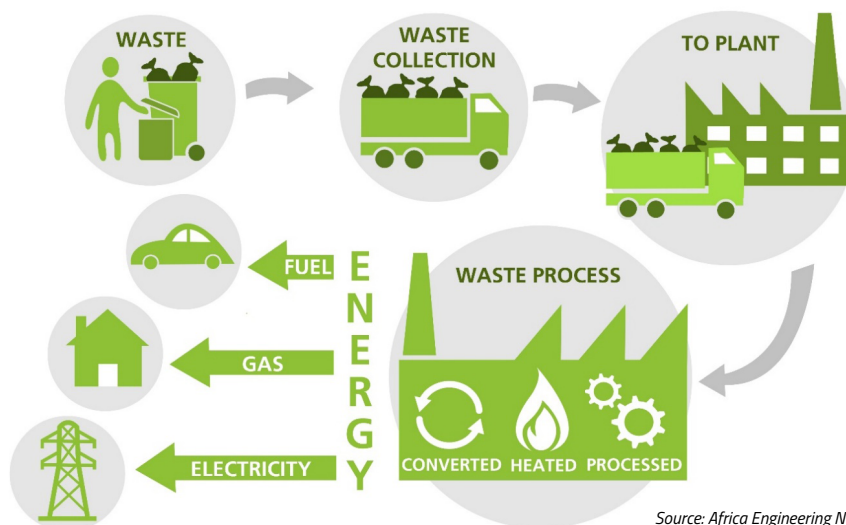
**Facts about Waste-to-Energy (WtE):**

- 1 ton of municipal solid waste (MSW)/trash = Approximately 1 MegaWatt (MW) of electricity
- 1 vehicle tire = 1 gallon of diesel
- 1 human = 2-4 pounds of waste (trash) per day

**Comparison among Energy Sources**

| Dominant Energy Sources in Use in Nigeria Today | | | | |
|---|---|---|---|---|
| **Power Plant Type** | **Cost $/kiloWatt-hr(kWh)** | **Feedstock for Energy** | **Pros** | **Cons** |
| Natural Gas | $0.07 - $0.14 | Gas | - Less Harmful than Coal or Oil<br>- Easy Storage & Transport<br>- Instant Energy<br>- Abundant | - Toxic & Flammable<br>- Damage to Environment<br>- Contributes to Greenhouse Gas Emissions<br>- Non-Renewable<br>- Complex & Expensive Process Installation |
| Coal | $0.10 - $0.15 | Coal | - Well Developed Technology<br>- Cheap & Reliable | - Contributes Major Pollution<br>- Non-Renewable<br>- Accidents |
| Hydro | $0.08 | Water | - Renewable/Green/Clean Energy<br>- Reliable/Stable<br>- Flexible & Safe | - Environmental Consequences<br>- Expensive to Build<br>- Droughts & Floods<br>- Limited Reservoirs |

| Renewable Energy for Nigeria to Adopt: Waste-to-Energy (WtE) | | | | |
|---|---|---|---|---|
| **Power Plant Type** | **Cost $/kiloWatt-hr(kWh)** | **Feedstock for Energy** | **Pros** | **Cons** |
| WtE (Biomass) | $0.10 | Waste / Trash | - Renewable/Green/Clean Energy<br>- Carbon Neutral (clean air)<br>- Reliable/Stable<br>- Widely Available<br>- Reduces Dependency on Fossil Fuels<br>- Reduces Waste/Pollution<br>- Reduces Landfills<br>- Power to Remote Areas<br>- By-Product Creation: e.g., steel, water, fertilizer, & fuels/diesel | - Initial Costs<br>- Requires Space<br>- Requires Waste |

*http://energyinformative.org and http://www.conserve-energy-future.com*

**16: Did you review the Waste-to-Energy (WtE) diagram and information?**

○ Yes
○ No (if no, an error message saying "Please review WtE Diagram")

**17: After viewing the diagram and information, I have a better understanding of the Waste-to-Energy (WtE) process?** (qCheck)

1. Strongly disagree
2. Disagree
3. Neither agree nor disagree
4. Agree
5. Strongly agree

**19: Waste-to-Energy (WtE) would provide Nigeria with more reliable energy.** (qAttitudes  belief-1a)

1. Strongly disagree
2. Disagree
3. Neither agree nor disagree
4. Agree
5. Strongly agree

**20: Waste-to-Energy (WtE) can provide sustainable energy creation to help meet Nigeria's energy demands.** (qAttitudes, beliefs)

1. Strongly disagree
2. Disagree
3. Neither agree nor disagree
4. Agree
5. Strongly agree

**21: Waste-to-Energy (WtE) would reduce pollution in Nigeria.** (qAttitudes, beliefs)

1. Strongly disagree
2. Disagree
3. Neither agree nor disagree
4. Agree
5. Strongly agree

**22: Waste-to-Energy (WtE) would contribute to a cleaner environment in Nigeria.** (qAttitudes, belief)

1. Strongly disagree
2. Disagree
3. Neither agree nor disagree
4. Agree
5. Strongly agree

**23: Meeting energy demand is not a problem in Nigeria.** (qAttitudes, belief)

1. Strongly disagree
2. Disagree
3. Neither agree nor disagree
4. Agree
5. Strongly agree


**24: Pollution is not a problem in Nigeria.** (qAttitudes, belief)

1. Strongly disagree
2. Disagree
3. Neither agree nor disagree
4. Agree
5. Strongly agree


**25: It is important for Nigeria to have an energy source that reduces pollution.** (qAttitudes, evaluation)

1. Strongly disagree
2. Disagree
3. Neither agree nor disagree
4. Agree
5. Strongly agree


**26: Protecting the environment is important for the well-being of Nigerians?** (qAttitudes, evaluation)

1. Strongly disagree
2. Disagree
3. Neither agree nor disagree
4. Agree
5. Strongly agree


**27: It is important for Nigeria to have a renewable energy source to help meet its power demand.** (qAttitudes, evaluation)

1. Strongly disagree
2. Disagree
3. Neither agree nor disagree
4. Agree
5. Strongly agree

**28: It is important for Nigeria to use renewable energy sources, such as Waste-to-Energy (WtE)?** (qAttitudes, evaluation)

1. Strongly disagree
2. Disagree
3. Neither agree nor disagree
4. Agree
5. Strongly agree

**29: Most people who are important to me think it would be a good idea to adopt Waste-to-Energy (WtE).**
(qSubject Norms, normative)

1. Strongly disagree
2. Disagree
3. Neither agree nor disagree
4. Agree
5. Strongly agree

**30: Most of my colleagues I know would want me to adopt Waste-to-Energy (WtE).** (qSubject Norms, normative)

1. Strongly disagree
2. Disagree
3. Neither agree nor disagree
4. Agree
5. Strongly agree

**31: When it comes to matters of adopting Waste-to-Energy (WtE), I want to do what my colleagues think I should do.**
(qSubject Norms, motivation)

1. Strongly disagree
2. Disagree
3. Neither agree nor disagree
4. Agree
5. Strongly agree

**32: When it comes to matters of adopting Waste-to-Energy (WtE), I want to do what other leaders think I should do.**
(qSubject Norms, motivation)

1. Strongly disagree
2. Disagree
3. Neither agree nor disagree
4. Agree
5. Strongly agree

**33: I intend to adopt Waste-to-Energy (WtE) as a renewable energy source to help meet Nigeria's power demands in Nigeria?**
(Intention)

1. Strongly disagree
2. Disagree
3. Neither agree nor disagree
4. Agree
5. Strongly agree

**34: I support the adoption of the Waste-to-Energy (WtE) process to produce energy in Nigeria.** (Intention)

1. Strongly disagree
2. Disagree
3. Neither agree nor disagree
4. Agree
5. Strongly agree

**35: I support the adoption of Waste-to-Energy (WtE) to reduce pollution in Nigeria.** (Intention)

1. Strongly disagree
2. Disagree
3. Neither agree nor disagree
4. Agree
5. Strongly agree

**36: I intend to promote Waste-to-Energy (WtE) as a viable energy solution in Nigeria.** (Intention)

1. Strongly disagree
2. Disagree
3. Neither agree nor disagree
4. Agree
5. Strongly agree

**37: I will advocate for the use of Waste-to-Energy (WtE) in Nigeria.** (Intention)

1. Strongly disagree
2. Disagree
3. Neither agree nor disagree
4. Agree
5. Strongly agree

**38: I do not intend to promote Waste-to-Energy (WtE) as an energy solution.** (Intention)

1. Strongly disagree
2. Disagree
3. Neither agree nor disagree
4. Agree
5. Strongly agree

**39: As part of a leadership effort, we can build acceptance of Waste-to-Energy (WtE) as a sustainable energy source for Nigeria.** (qLeadership acceptance)

1. Strongly disagree
2. Disagree
3. Neither agree nor disagree
4. Agree
5. Strongly agree

**40: Nigerian leaders must accept change from using only current energy sources (e.g., natural gas, coal) to adopt the use of Waste-to-Energy (WtE) in Nigeria.** (qLeadership acceptance)

1. Strongly disagree
2. Disagree
3. Neither agree nor disagree
4. Agree
5. Strongly agree

**41: As Nigerian leaders, we have the ability to explore and pursue Waste-to-Energy (WtE) Adoption** (qLeadership ability)

1. Strongly disagree
2. Disagree
3. Neither agree nor disagree
4. Agree
5. Strongly agree

**42: As part of a leadership effort, we have limited ability to explore and pursue Waste-to-Energy (WtE) adoption.** (qLeadership ability)

1. Strongly disagree
2. Disagree
3. Neither agree nor disagree
4. Agree
5. Strongly agree

**43: As part of a leadership effort, we have the authority to explore and pursue Waste-to-Energy (WtE) adoption.**
(qLeadership authority)

1. Strongly disagree
2. Disagree
3. Neither agree nor disagree
4. Agree
5. Strongly agree

**44: As part of a leadership effort, we have limited authority to explore and pursue Waste-to-Energy (WtE) adoption.**
(qLeadership authority)

1. Strongly disagree
2. Disagree
3. Neither agree nor disagree
4. Agree
5. Strongly agree

**45: In an effort to adopt Waste-to-Energy (WtE) as a long-term solution to Nigeria's energy needs and environmental concerns, PLEASE indicate the extent to which youagree or disagree that YOU WOULD DO THE FOLLOWING:** (qBehavior)

| I WOULD: | Strongly Disagree | Disagree | Not agree or disagree | Agree | Strongly Agree |
|---|---|---|---|---|---|
| Sign a letter of support for WtE | | | | | |
| Attend meeting with colleagues/leaders to support WtE adoption in Nigeria | | | | | |
| Show support publicly for the adoption of WtE in Nigeria | | | | | |
| Support allocated resources to use WtE in Nigeria | | | | | |
| Learn more about WtE | | | | | |
| Other –– Please share what you would do: | *(This is an open text box in Qualtrics)* | | | | |

**46: If you wish, please share with us any additional thoughts you may have about energy or pollution concerns in Nigeria:**

**Table 1: Measurement Model Outer VIF Values**

|  | VIF |
|---|---|
| Attitudes * Leadership-Led | 1 |
| Q19 | 2.779 |
| Q20 | 2.635 |
| Q21 | 2.347 |
| Q22 | 2.66 |
| Q25 | 1.794 |
| Q26 | 2.172 |
| Q27 | 2.103 |
| Q28 | 2.348 |
| Q29 | 1.845 |
| Q30 | 2.083 |
| Q31 | 2.391 |
| Q32 | 2.163 |
| Q33 | 2.408 |
| Q34 | 2.17 |
| Q35 | 1.844 |
| Q36 | 2.545 |
| Q37 | 2.692 |
| Q39 | 1.459 |
| Q40 | 1.506 |
| Q41 | 1.6 |
| Q43 | 1.327 |
| Q45_1 | 2.542 |
| Q45_2 | 2.866 |
| Q45_3 | 2.657 |
| Q45_4 | 2.188 |
| Q45_5 | 2.275 |

VIFs scores are all below 3.0, indicating that there are no collinearity issues among the indicators of the formatively measured constructs (Hair et al., 2018).

**Table 2: Structural Model: Outer Model VIFs**

| | Leadership-Led | WtE Behavior | WtE Intention |
|---|---|---|---|
| Attitudes | 1 | | 1.983 |
| Leadership-Led | | | 2.147 |
| Subjective Norms | | | 1.242 |
| WtE Behavior | | | |
| WtE Intention | | 1 | |

**Table 3: Construct Cross-Validated Redundancy (Blindfolding)**

| | $Q^2$ (=1-SSE/SSO) |
|---|---|
| Leadership-Led | 0.224 |
| WtE Intention | 0.395 |
| WtE Behavior | 0.05 |

**Table 4: Descriptive Statistics**

| Characteristics | Sample *N* | Sample *%* | Characteristics | Sample *N* | Sample *%* |
|---|---|---|---|---|---|
| Gender | | | Age | | |
| ▪ Male | 12 | 67 | Mean (SD) | 46.84(8.78) | |
| ▪ Female | 3 | 33 | Median | 47 | |
| *Total* | 81 | 100 | | | |
| Geo Location | | | Education | | |
| ▪ East | 22 | 12.0 | Up to HS | 1 | .5 |
| ▪ West | 31 | 16.8 | HS Degree | 3 | 1.6 |
| ▪ North | 90 | 48.9 | Some College | 3 | 1.6 |
| ▪ South | 41 | 22.3 | UG Degree | 26 | 14.1 |
| *Total* | 184 | 100 | Grad Degree+ | 151 | 82.1 |
| | | | *Total* | 184 | 100 |

| Location Population | Sample *N* | Sample *%* |
|---|---|---|
| ▪ Major Metro area (pop. over 2M) | 79 | 42.9 |
| ▪ City (pop. 1M–2M) | 76 | 41.3 |
| ▪ Small City (pop. 500,000–999,999) | 21 | 11.4 |
| ▪ Town (pop. 100,000–499,999) | 8 | 4.3 |
| *Total* | 184 | 100 |

| Leader Experience by sector (can be multiple) | Sample *N* | Sample *%* |
|---|---|---|
| ▪ Leader in government sector | 111 | 60.3 |
| ▪ Leader in private sector | 67 | 36.4 |
| ▪ Leader in community sector (e.g., Pastor, Chief, Tribe) | 38 | 20.7 |
| ▪ Leader in military sector | 8 | 4.3 |
| *Total* | 224 | 100 |

| Years in Leadership Role/Position | Sample *N* | Sample *%* |
|---|---|---|
| ▪ 1-5 years | 22 | 12.5 |
| ▪ 6-10 years | 42 | 22.8 |
| ▪ 11-15 years | 42 | 22.8 |
| ▪ 16-20 years | 41 | 22.3 |
| ▪ Greater than 20 years | 36 | 19.6 |
| *Total* | 184 | 100 |

| Knowledge about Renewable Energy (Solar, Wind, WtE) | Sample *N* | Sample *%* |
|---|---|---|
| Not at all knowledgeable | 3 | 1.6 |
| Not knowledgeable | 11 | 6.0 |
| Somewhat knowledgeable | 68 | 37.0 |
| Very knowledgeable | 74 | 40.2 |
| Extremely knowledgeable | 28 | 15.2 |
| *Total* | 184 | 100 |
| Familiarity with Waste-to-Energy (WtE) | Sample *N* | Sample *%* |
| Not at all familiar | 4 | 2.2 |
| Not familiar | 16 | 8.7 |
| Somewhat familiar | 55 | 29.9 |
| Very familiar | 88 | 47.8 |
| Extremely familiar | 21 | 11.4 |
| *Total* | 184 | 100 |

**Table 5: Levels of Support for Study Hypotheses**

| H# | Hyphothesis | |
|---|---|---|
| H1 | Leaders with positive attitudes about WtE will have a positive intention to adopt WtE. | Supported *** |
| H2 | Leaders with positive subjective norms about WtE will have a positive intention to adopt WtE. | * |
| H3 | Leaders who have positive intentions to adopt WtE will positively affect leaders' behaviors to adopt WtE. | Supported *** |
| H4 | Leadership-led change mediates the relationship between leaders' attitudes about WtE and their intention to adopt WtE. | Supported *** *(Partial Mediation)* |
| Note: ***p<.01; **p<.05, *p<.10 | | |

**Figure 7** *Word Cloud Derived from Survey Comments*

## ABOUT THE AUTHORS

**Jahan Moghadam** has over 25 years of global executive experience in consulting, training, and energy sectors. He has been a key member of exec teams that have successfully executed business development, operations, and strategy on renewable energy, oil & gas, commodities, and technology projects throughout Africa, Asia, Europe, and the Americas. He previously served as an exec and board member of Amira Int'l, ICCOEC, GWECC, and more, and is current exec/board member of WorldWide Solutions (WWS), WorldWide Energy (WWE), Oranto Petroleum and iEg. He has published in journals such as *The International Journal of Environmental Sustainability* and *Engaged Management ReView.* Jahan presents at many workshops and seminars on leaderships and executive decision making around the world. Jahan holds a B.S. with honors from James Madison University, an M.S. from the University of Virginia, and a D.B.A. from Georgia State University. He currently sits on the Advisory Board for the McIntire School at the University of Virginia, a non-profit ShareACause, and more.

**Karen Loch's** research spans the areas of international business, decision making, social and ethical concerns of IS and disruptive technologies with an interest in bringing insights to real world problems. A recipient of two NSF grants sponsoring field research in the Middle East, a research program spanning 12 years, Karen has published in leading IS journals, such as *MIS Quarterly, Information Systems Journal, Journal of Business Ethics, DATA BASE, Journal of Global Information Management* and others, and co-authored a book on IT education. Professor of the Robinson College of Business at Georgia State University for over 30 years, Karen also worked in the corporate world in the insurance and publishing industries, and as a technology consultant with her own consulting firm. Karen received her Ph.D. in Management Information Systems from the University of Nebraska-Lincoln, and a M.A. in French language and literature.

**Kamran Khan Niazi** is a development economist by training and currently working at the United Nations conducting internal assessments and evaluations. Kamran has previously worked with IFC, J-PAL and SIDA among other multilateral development institutes. With extensive previous experience in impact evaluations, quantitative research designs and evaluations, Kamran has worked in research domains including governance, political economy, renewable energy, and trade. Kamran is also pursuing a full-time degree in International Affairs at Geneva Graduate Institute and previously completed a Masters in Development Economics from Toulouse School of Economics in 2014.