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Factors influencing willingness to adopt renewable energy technologies among micro and small enterprises in Lagos State Nigeria

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ABSTRACT

Micro and small enterprises (MSEs) are the engine of economic growth in Nigeria. But they also contribute heavily to the climate change through their choice of energy. Mostly prefer source is the fossil fuel for electricity generation despite the growing awareness of the need to reduce greenhouse gas emissions by embracing renewable energy technologies across the globe. Meanwhile, MSEs accounts for a large proportion of businesses in Lagos State, Nigeria and the situation is not different. Hence, this study investigated the factors influencing willingness to adopt renewable energy technologies among the MSEs. The study surveyed 385 MSEs between January and March, 2017 in Lagos State, Nigeria but found 223 suitable for the analysis. Using logit regression, the results showed that creating awareness and knowledge about renewable energy, adequate government policies, trust, peer-effect, development of renewable energy markets and technology acceptance factors (if it makes life easier, simple to use and improve the quality of work) are all positive and statistically significant in influencing the willingness to adopt renewable energy technologies among the MSEs. Cooperation between private enterprises and relevant government agencies supported by 'political will' is required to promote the aforementioned factors influencing the willingness to adopt RETs in Nigeria.

Keywords:

Renewable energy technology;
Willingness to adopt;
Micro and Small Enterprises;
Technology acceptance;
Nigeria;

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1. Introduction

The need for renewable energy to serve as an alternative to fossil fuel is no longer news across the globe. This is not because renewable energy is cheap compared to fossil fuels; rather the negative environmental and health effects fossil fuels have on the general populace may be irreversible. Energy is one of the indispensable factors for continuous development and economic growth [1, 2, 3, 4].

Conversely, energy usage also contributes to environment degradation, such as air pollution, soil contamination and rise in sea level otherwise known as climate change. Renewable energy offers the opportunity to contribute to a number of important sustainable development goals among which are: social and economic development, energy access, energy security, climate change mitigation and the reduction of environmental and health problems. The mitigation of dangerous anthropogenic climate change is seen as one strong driving force behind the increased use of renewable energy worldwide.

Lastly, the demand for energy is expected to increase worldwide over the next 30 years [5], and particularly in developing countries such as Nigeria where rapid

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economic growth is expected. Adoption of renewable energy could lead to environmental quality, and creating awareness about environmental protection and sustainable development would promote people's adoption behaviour. It is anticipated that a shift in public awareness of environmental issues would result into a significant changes in the public understanding and acceptance of climate change [43]. This is based on the premises that awareness of renewable energy would affect willingness to adopt it which would eventually affect its adoption as inferred from Theory of Reasoned Action and Technology Acceptance Model.

Most businesses in Lagos state, which is the commercial hub of Nigeria, are mainly micro, small and medium enterprises. The majority of these enterprises are currently using diesel-powered generators to privately generate electricity to support their businesses since there is high shortage of electric power from the national grid [54]. Recently, it has been noticed that some of them have started using solar energy and rechargeable inverters to support their electricity needs. The role played by micro and small enterprises in various countries cannot be undermined as majority of households operate businesses within that scale.

Micro, Small and Medium Enterprises (MSMEs) have been said to contribute largely to GDP worldwide [6, 7], thus it becomes necessary to study the use of energy amongst these enterprises. According to Nigeria's National Bureau of Statistics [8], MSMEs in Nigeria contribute an average of 48.5% in nominal terms to GDP and 7.3% to exports. This further reiterates the importance of MSMEs which cannot be overemphasized in the Nigerian economy. Meanwhile, it is noteworthy to state that there are many MSMEs in the informal sector not captured by the National Bureau of Statistics.

This study concentrates on Lagos State which is the former capital city of Nigeria. There are presently 36 States in Nigeria with Federal Capital Territory (FCT) inclusive. Lagos State has a mean monthly maximum temperature which steady around 90˚F (32˚C) and the mean monthly minimum temperature of approximately 72˚F (22˚C), with a land mass of 3,671 square kilometres. The State being the commercial hub of the country has an estimated population of over 12 million in 2015 (base on the 2015 estimations) but many unofficial private institutions put the current population of Lagos State to be above 20 million people.

The State has a youth literacy rate of 99.3% in any language and the highest adult literacy rate 92.3%, as well as the lowest severity of poverty rate of 1.1%. Furthermore, Lagos State has the highest consumption of PMS otherwise known as petrol (19.2%) out of all states in the country followed by FCT (8.7%) and Ogun State (5.86%) as at year 2015 [51]. Moreso, Lagos State consumed 44.8% of the country's diesel followed by Rivers and Ogun States with 14.87% and 8.47% respectively. In addition to this, 18.2% of the Country's kerosene was consumed by Lagos residents, followed by 8.72% and 5.6% consumed by FCT and Oyo States as at end of 2015 [51]. Meanwhile, the State also records the highest movement of cargo traffic and passengers on aircrafts and ships at both the airports and the seaports. All these attract businesses from all over the globe to Lagos State. This makes Lagos State a good place to deploy renewable energy in Nigeria.

Due to the large number of micro and small enterprises in Nigeria, there is a need to investigate the level of awareness of renewable energy as well as the factors that could be influencing their willingness to adopt renewable energy technologies as alternatives to fossil fuels in Lagos State. It has been documented in the industrialised countries that public acceptance of renewable energy technologies is crucial to their successful introduction into society [9, 10]. This is because poor public acceptance of renewable energy technologies could hinder the implementation of sustainable energy technologies which hampers the attainment of important environmental and societal goals [11].

The article is divided into five sections. Section 1 introduces the article; section 2 presents the theoretical and empirical reviews as well as the status of micro and small enterprises in Nigeria. Section 3 and 4 present the methodology used to carry out the study and results analyses respectively, while section 5 concludes the article.

2. Literature review and theoretical framework

This section provides the theories and empirical reviews of the study as well as the status of MSEs in Nigeria.

2.1. Theory of reasoned action and technology acceptance model

The theory of reasoned action (TRA) provides a model and explains how and why attitude affects behaviour [12, 13]. According to the theory, intention to perform certain behaviour precedes the actual behaviour. This intention is known as behavioural intention, and comes as a result of the idea that performing behaviour will

lead to a specific outcome [14]. Behavioural intention is important to the theory because these intentions are determined by attitudes to behaviours and subjective norms as shown in Figure 1. Feng [15] stated that an individual's behaviour is determined by his/her attitude toward the outcome of that behaviour and by the opinions of others within his social environment. Based on this TRA, the first determinant is personal to each individual which is called "attitude towards the behaviour" and refers to *attitudinal factors.* The second determinant of intention is the individual's perception of the social pressure put on him/her to perform or not to perform a particular behaviour and refers to *subjective norm.*

On the other hand, technology acceptance model (TAM) was an offshoot of TRA, and was first developed by Davis in 1986 [16]. TAM explains how users acquire, learn, accept and use a technology. The model suggests that when users are presented with a new technology, a number of factors influence their decision about how and when they will use it. TAM provides a basis with which one traces how external variables influence belief, attitude, and intention to use. The two main factors influencing the intentions to use a particular technology are *perceived usefulness,* which is a degree to which a person believes that using a particular system will improve his job's output; and *perceived ease of use* is the degree to which a person believes that using a particular system would be free from effort.

Figure 2 showing the TAM depicts that one's actual use of a technology system is influenced directly or indirectly by the user's behavioural intentions, attitude,

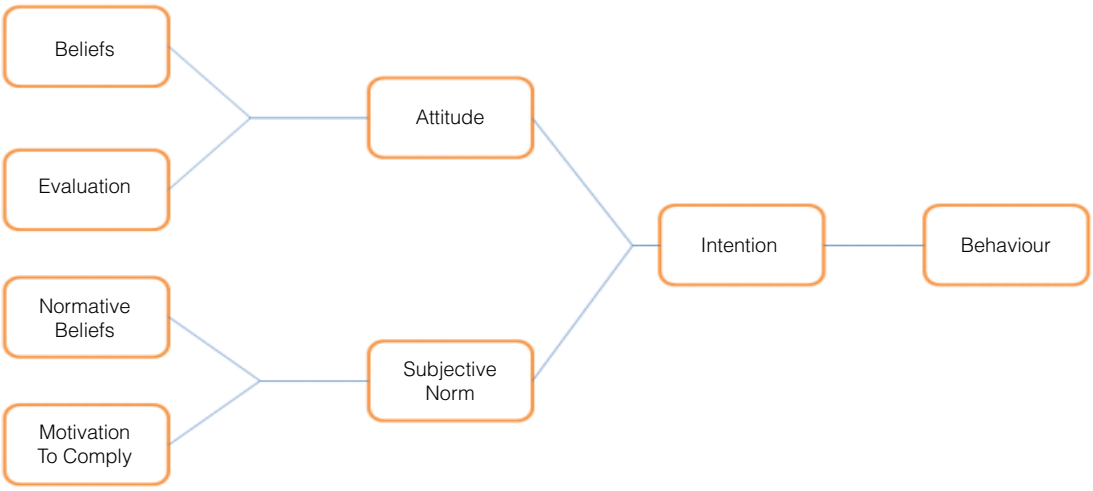

Figure 1: Theory of reasoned action Source: Ajzen and Fishbein [12, 13]

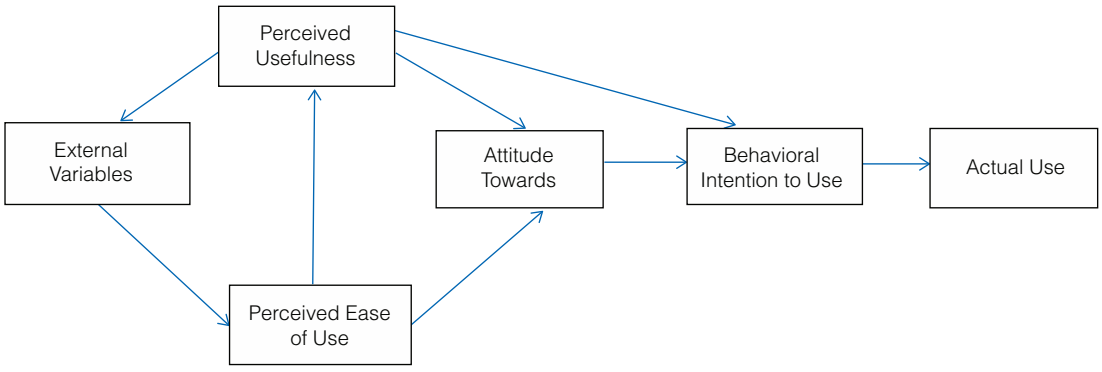

Figure 2: Technology acceptance model. Source: Davis [19]

perceived usefulness of the system, perceived ease of the system [17]. TAM also proposes that external factors affect intention and actual use through mediated effects on perceived usefulness and perceived ease of use.

Consequently, the predictive capacity inherent in the theory of reasoned action [18] and the technology acceptance model may have relevance to evaluate decision making within the small business field, hence warrants the use of these theories for this study.

2.2. Empirical literature on the willingness to adopt renewable energy sources

The findings of Bollinger and Gillingham [20] shed light on the role of spatial peer-effect of diffused renewable energy technologies (DRETs) generally and solar photovoltaic (PV) systems specifically in California. Their studies among others found that peer-effect, personal attitude/values and favourable subsidies have influenced the willingness to adopt a solar PV technology [20, 21]. The socioeconomic and demographic characteristics of agents adopting technologies and those of the agents' surroundings are the focus of many studies in DRETs diffusion. Agents act like other 'peers' for two main reasons: for emulating someone perceived as guidance; or for reducing the risk associated in being an innovator [20]. The physical presence of the solar panels in the market creates a sense of security, reducing the perceived risk for potential adopters and showing the change from the business-as-usual is possible.

Snape and Rynikiewicz [22] investigated the same effect in the UK and their results shows stronger adoption in regions where agents first adopted photovoltaic systems and a concentric pattern, with lower adoption in the further areas. According to Fischer and Sauter [23], social references seem to influence both acceptance and resistance to renewable energy technologies as friends and neighbours seem to be important references for investing in solar panels. Also, friends' and relatives' opinions were found to be important determinants of people's views on local renewable energy projects [24]. Heaslip et al. [9] also found in their studies conducted in Denmark and Ireland that the extent of community involvement (social factor) in the development of sustainable energy community projects is a significant factor determining the acceptance of such energy projects in the community. The community involvement which involved regular public meetings with the people in the community and funding policy to encourage the citizens is also revealed in the study of Reinsberger and Posch [25] as factors which influence photovoltaic adoption in Austria.

Hotel Energy Solutions [26] conducted a study based on an in-depth interview on the factors and initiatives affecting renewable energy technologies adoption among the European Union small and medium enterprises in the hotel industry. The study found that cost of installations, distance from the renewable manufacturers, lack of adequate information and low awareness of RES benefits among local and regional authorities as well as unclear formal requirements are the main factors affecting renewable energy technologies adoption among the SMEs in the hotel industry. Ng'eno [27] also conducted a study among household in Kenya on the factors affecting the adoption of solar power technology for domestic power usage. The study revealed that the level of knowledge and awareness of solar technology, level of income of households, and availability of substitute power source influence the adoption of domestic solar technology.

Some studies pointed out that government policy is an important factor influencing willingness to adopt renewable energy [28]. Renewable energy technologies (RETs) could face opposition and barriers due to public perception, policy design, Not In My Backyard (NIMBY) syndrome and lack of information about its impact on landscape and the environment [10, 28, 29, 30, 31]. Policies can either accelerate or slow down the diffusion of RETs [28, 32, 33]. Verbruggen et al. [33] argued that policies affect directly DRETs costs, prices, and technology innovation. Mattes et al. [34] using the German data of the European Manufacturing Survey 2012 found that access to renewable energy resources, size of firm, location of firm, financial resources, policy mix in terms of political and legal frameworks are major factors influencing the adoption of renewable energy technologies among the German firms in the manufacturing sector.

According to Graziano [35], education influences decision of adopting agents in various ways. Education affects the pre-adoption process in that it provides adopting agents with the tools to understand and be acquainted with the direct and indirect advantages of adopting RETs. Few studies have shown that higher education attainment and training increase the likelihood of RETs' adoption [21, 36] as information plays a key

role in the diffusion of DRETs. Knowledge about the existence of RETs, their accessibility, their role and advantages positively affects acceptance and adoption [9, 10, 21, 36, 37]. Correlations between knowledge of a technology and acceptance of the technology have been studied more widely. For hydrogen technology acceptance, mostly positive effects of its knowledge on acceptance of the technology have been found [38, 39, 40, 41]. These studies have shown that people with more knowledge on hydrogen as a fuel perceived less safety risks, which was related to a positive attitude towards using hydrogen as a fuel and willingness to use hydrogen fuel technologies.

Feng [15] analysed the key factors that affect users' intentions of adopting renewable energy technologies in Taiwan. With a total of 273 persons interviewed to comprehend their attitude and behaviour concerning renewable energy technologies. Theory of Reasoned Action, Technology Acceptance Model and Roger's Diffusion of Innovations were the basis for the study. The results of the study showed that perceived usefulness (such as whether the system is better than previous used, the economic benefit to gain, the convenience and satisfaction for using it), subjective norm (such as the influence of friends and families), compatibility (such as the past experiences of a person and the present demand) and perceived ease of use (such as understanding of how easy it is to use the system) are major factors influencing the adoption of renewable energy technologies among the sampled respondents. Unlike many other literatures, the result of this research also found that income is not a significant variable as it does not affect attitude toward the use of RET. Studies on the acceptance of carbon capture and storage showed that perceived risks and benefits of these technologies indeed predict attitude towards the technology [42]. The study also revealed that costs, risks and benefits of the technology also influence choices.

Huijts et al. [12] explained the intention to act in favour or against new sustainable energy technologies, which is influenced by attitude, social norms, perceived behavioural control, and personal norm. In the framework, attitude is influenced by the perceived costs, risks and benefits, positive and negative feelings in response to the technology, trust, procedural fairness and distributive fairness.

Shen et al. [43] examined factors influencing adoption and sustainable use of clean fuels and cook stoves in China. They found that household characteristics (such as family size, age, gender, household income, location and structure), knowledge and public awareness about the technology (such as higher education, publicity and demonstration), policy and regulations, financial support from the government and renewable energy market development are all significant in influencing the adoption of clean fuels and cooking stoves in China.

There are few studies which have examined the awareness and attitudes of members of the public towards renewable energy usage in Nigeria [1, 48, 52, 53]. However, there is a dearth of study being conducted on the adoption of renewable energies among micro and small enterprises in Nigeria despite that this category of business constitutes a large number in the Country. Majority of these businesses utilise privately owned fossil fuel energy generators to carry out their daily business activities as there is a limited supply of electricity from the national grid. Hence, this study investigates the factors influencing adoption of renewable energy among MSEs due to the importance of these factors and given the lack of study particularly on MSEs in Nigeria that would allow the dynamics of their acceptance.

2.3. Status of the micro, small and medium enterprises in Nigeria

The contribution of Micro, Small and Medium Enterprises (MSME's to the economic growth of a nation is well documented. Study findings on MSME in many developing countries have indicated that countries with larger share of MSME employment have higher economic growth than their counterparts [44]. In fact, it is suggested that one of the significant characteristics of a flourishing and growing economy is a booming and blooming MSMEs sector [8]. MSME therefore play an important role in the development of a country by creating employment for rural and urban growing labour force, providing desirable sustainability and innovation in the economy as a whole [5]. Moreso, a large number of people rely on the small and medium enterprises directly or indirectly in Nigeria [8].

It is important to provide some categories in which Micro, Small and Medium enterprise have been defined. Individual countries' circumstances determine how MSME is being defined in that country, for instance some countries define it (MSME) by the total assets,

others by employment, turnover, or paid-up capital. However, in Nigeria, the current classification is based on the number of employees and assets (excluding land and buildings) as depicted in Table 1 [8]. In practice, the number of employees is the most common standard used in National SME policies worldwide.

It is possible under the criteria stated in Table 1 above that a conflict of classification may arise. In such cases, the employment-based classification will take precedence.

According to [8], MSMEs contribution to Gross Domestic Product in nominal terms stood at 48.47% and contribution to exports at7.27%. Figure 3 shows the contributions of MSMEs to GDP by economic sector. While services sector accounted for 45.72% of the total, Agriculture accounted for 42.02% and Industry accounted for 12.26%.

As of 2010, the majority (99.87%) of the MSMEs were micro enterprises, 0.12% was small enterprises while 0.01% was medium enterprises [8]. From the total number of micro enterprises, Trade accounted for the majority (54%) followed by Manufacturing (13%), Agriculture (9%), and other services (7%) among others. From the small and medium enterprises, majority (35%) of the enterprises are in Education sector, followed by Trade (22%) and Manufacturing (20%) among others.

The MSMEs in Nigeria have been facing some challenges which are responsible for their slow growth and development. These include limited capacity for research and development, low adoption of technological innovation, poor infrastructural facilities, epileptic power supply, poor financing and lack of government supports, poor access to banks' credit, inadequate managerial and entrepreneurial skills, limited demand for their products and services, inability to compete at international market, burden of multiple taxes, and imperious actions of government functionaries and agents [45]. However, Spencer and Kirchhoff [46] regarded many small enterprises as "ideal types" of new technology-based enterprises that are key drivers of innovation and economic growth. These enterprises are characterized with the fast adopters of new technologies. Some of these MSMEs across industries and economies have the unrealized innovation potential [47]. Many MSMEs in Nigeria have been forced out of business as a result of the poor electricity supply [48]. The estimated total installed capacity of gas and hydro power stations in Nigeria is 8,000 MW, whereas the power generation capacity available is approximately 4,000 MW from which less than 3,000 MW is readily available to generate electricity [1, 49]. Nigerian businesses have relied so much on diesel generating sets to provide electricity for themselves but the cost of running self-generating sets is too high apart from the health hazards attached to the fossil fuel burning. Hence, there is need to adopt new, cleaner and sustainable technologies to supply electricity to the MSMEs, but their willingness to adopt such technologies need to be examined.

3. Methodology of the study

The methodology section contains the data and sample sub-section which is followed by the description of measurements of variables and logistic regression.

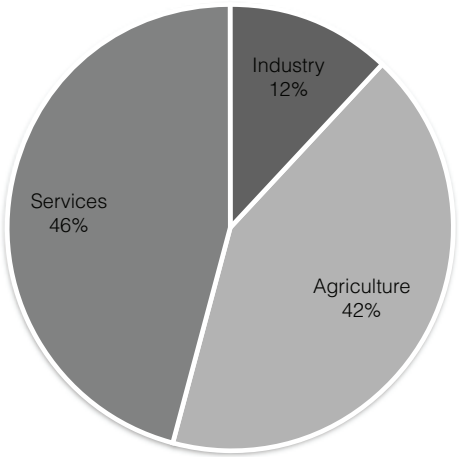

Figure 3: Contribution of MSMEs to GDP by economic sector in Nigeria Source: [8]

Table 1: Classification of micro, small and medium enterprises in Nigeria

S/N	Size Category	Employment	Assets (₦ million) (excluding land and buildings)
1	Micro Enterprises	Less than 10	Less than 5
2	Small Enterprises	10 to 49	5 to less than 50
3	Medium Enterprises	50 to 199	50 to less than 500

Source: [8]

3.1 Data and sample population

As a result of dearth of information as regards the micro and small enterprises' adoption of renewable energy in the national statistics, this study employed research survey design to collect primary data and obtained the required information. Primary data is questionnaire based, and measurements are dichotomous responses. For a large populations, Cochran [59] found in Israel [60] developed the Eq. (1) to yield a representative sample for proportions.

$$n_o = \frac{z^2 pq}{e^2} \quad (1)$$

This is valid where n_o is the sample size, e is the desired level of precision (e=.05), p is the estimated proportion of an attribute that is present in the population (assumed p=.5 i.e. maximum variability) and q is 1-p. The value of z is found in statistical tables which contain the area under the normal curve (z=1.96). A total of 385 questionnaire were calculated and administered among the MSEs across the five administrative zones (popularly known with the acronym 'IBILE' which include Ikeja, Badagry, Ikorodu, Lagos Island and Epe) of Lagos State being the commercial hub of Nigeria in the first quarter of year 2017. The study was able to retrieved only 300 questionnaire out of which only 223 questionnaire were found useful due to large numbers of incomplete information from the discarded questionnaire.

The questionnaire administration involved random sampling without replacement which elicited information from the MSEs on their knowledge of renewable energy technologies and other key factors influencing their willingness to adopt renewable energy sources. Some of these factors include their level of awareness about renewable energy, education, training, financial support and policy of government, size of firm, age of firm, location, market development, income and trust among others. The study uses descriptive statistics and logit regression to analyse the data.

3.2 Measurement of variables

The specific objective of the study is to examine the factors influencing the willingness to adopt renewable energy technologies among the micro and small enterprises in Nigeria. Based on the literature, the following questions were used to capture the independent variables in Eq. (2) below:

X_1: Do you think having more knowledge and awareness about renewable energy technology will influence your adoption of it;

X_2: Do you think that adequate government policies and standards for the production of renewable energy equipment and protection of consumers will influence you in adopting renewable energy sources;

X_3: Will the development of renewable energy market that supplies the required accessories continuously affect your willingness to adopt renewable energy sources;

X_4: Do you think level of participation of local residents in the planning and implementation process of renewable energy technologies in your environment can influence extent of adoption of renewable energy in your enterprise;

X_5: Do you think your previous experience of using renewable energy technology can influence its adoption;

X_6: Trust in Stakeholders who are responsible for the renewable energy technology (such as regulators or owners of the technology) will influence my willingness to adopt it;

X_7: I will adopt renewable powered electricity if it makes life easier for me;

X_8: I will readily use renewable energy if it is simple to use and maintain;

X_9: Using renewable energy would improve my job quality and my standard of living;

X_{10}: Do you think the influence of other businesses in your area will encourage you to adopt renewable energy technologies?

The ten aforementioned questions are measured in binary terms (Yes or No). Also the dependent variable, which is, willingness to adopt renewable energy by the MSEs is also measured in binary term. Each enterprise is asked whether it is willing to adopt renewable energy or not. Since the dependent variable is binary, the logit regression is therefore adopted for analysis.

The binary logit model involves dichotomous dependent variable whose probabilities, conditional upon explanatory variables are modelled [50]. Since there can be two choices such as whether the enterprise is willing to adopt renewable energy or not, then a simple logit model is relevant. A binary regression with (0, 1) choice is represented as

$$y_i^* = \beta' X_i + \varepsilon_i \quad (2)$$

Where from Eq. (2), y_i^* is a latent variable and β' is the coefficient of explanatory variables Xi^*. The latent

variable y_i* is not directly observable rather what is observable is a dummy variable y_i which depict whether the enterprise is willing to adopt renewable energy (i.e. $y_i = 1$) or is not willing to adopt renewable energy (i.e. $y_i = 0$). A logistic function $G(\beta' X_i)$, where $0< G(\beta' X_i)<1$ which is the cumulative distribution function (CDF) for a standard logistic random variable can be stated as in Eq. (3).

$$G(\beta' X_i) = \frac{exp\,(\beta' X_i)}{1 + exp\,(\beta' X_i)} \quad (3)$$

If the probability of willingness to adopt RE is $p(y_t = 1) = G(\beta' X_t)$, then the probability of not willing to adopt will be $p(y_t = 0) = [1 - p(y_t = 1)] = 1 - G(\beta' X_t)$. Meanwhile, the ratio of the two probabilities (e.g willingness and non-willingness to adopt RE) can be referred to as the 'odd ratio' which can be expressed as in Eq. (4).

$$\frac{p}{1-p} = \frac{G(\beta' X_i)}{1 - G(\beta' X_i)} \quad (4)$$

This can be expressed in logarithmic function which is a standard logistic model, where binary dependent variable's behaviour is captured by the log-odds ratio as in Eq. (5).

$$In\frac{p}{1-p} = In(exp(\beta' X_i)) = \beta' X_i \quad (5)$$

Logit regression use maximum likelihood (ML) method to estimate parameters in the model. The ML of the models above is given by the product of the probabilities of RE adoption success and non-adoption. The coefficients of the logit model, like the ordinary regression coefficient, define the parameter estimates. These coefficients signify that a unit increase in the independent variable (X_t) listed above as X_1 to X_{10} produces $ß_t$ change in the log odds of the dependent variable. Positive sign for the coefficients indicate that the log of the odds ratio of the dependent variable increases as the value of the independent variable rises and vice versa. The logit coefficients are in 'log-odds' units and are therefore usually converted into 'odds ratios' for a more intuitive explanation. Also, pseudo- R_2 based on the log likelihood, which is (1 – the ratio of unrestricted and restricted log likelihood) is used to measure goodness of fit in logit model and it varies from 0 to 1.

4. Results and the analyses

This section presents the obtained background information of the owners of MSEs, characteristics of the enterprises, and results of the regression analysis conducted from the study.

4.1 Descriptive analysis

Table 2 revealed that ages of the majority of the owners of the MSEs sampled are between 26-40 years (53.4%) and 41-60 years (31.8%). This showed that majority of the MSEs in these areas are middle-aged between 26-60 years as many that fall below this age might still be schooling at various academic institutions or learning one trade or the other. Table 2 also showed that 47% of the owners of the MSEs have Bachelor's degree and equivalents as their highest academic qualifications, followed by 20.5% of them who had master's degree as their highest academic qualification.

This implies that majority of the respondents have academic qualification expected to enable them access requisite information and knowledge about their businesses and renewable energy. Table 3 indicated that trading (23.7%), services (22.7%), manufacturing (20.5%), agriculture (12.5%) and information technology related businesses (9.1%) constitute the largest proportion of MSEs' businesses respectively. 78.4% and 21.6% of the sampled MSEs are located in the urban centre and rural area respectively.

Table 2: Personal characteristics of the owners of the MSEs

Characteristics	%
Age	
Below 25	5.7
26-40	53.4
41-60	31.8
Above 60	9.1
Highest academic qualification	
Primary School Certificate	2.3
Senior Secondary School Certificate	8
National College of Education Cert.	4.5
National Diploma	9.1
Bachelor's degree and equivalents	46.6
Postgraduate Diploma	5.7
Masters	20.5
Doctorate	3.4

Table 3: Nature and location of the MSEs

Nature of businesses and the location	%
Nature of business	
Trading	23.7
Information technology	9.1
Pharmaceuticals	3.4
Catering	4.5
Hotel	2.3
Manufacturing	20.5
Services	22.7
Agriculture	12.5
Others	2.3
Location of businesses	
Urban	78.4
Rural	21.6

Table 4: Size, profit and number of years of establishment

Size, Age and Profit of the MSEs	%
Size of enterprise	
Less than 10	65.9
Between 10 and 50	34.1
Age of enterprise (number of years of establishment)	
Less than 2 years	3.4
2 – 5 years	45.5
5 – 10 years	26.1
Above 10 years	25
Monthly profit of the MSE	
Less than ₦100,000	15.9
₦100,000 to ₦500,000	47.7
Above N500,000	36.4

Table 5: Correlation Analysis

S/No	Variables	1	2	3	4	5	6	7	8
1	Willingness to adopt RETs	1							
2	Age of the owners	0.55	1						
3	Highest Acad. Qualification	0.48*	0.72**	1					
4	Nature of business	0.61*	0.13	0.44*	1				
5	Size of enterprise	0.38*	-0.51	0.32	0.38	1			
6	Age of enterprise	0.51*	0.24	0.53	0.28	0.42	1		
7	Monthly profit	-0.49	0.39	0.48*	-0.22	0.40	0.63*	1	
8	Location of business	0.52*	0.22*	0.51	0.33*	0.43	0.48*	0.28*	1

*p < 0.1
**p < 0.05

Approximately 66% of the enterprises are micro with less than 10 employees while 34% are small enterprises between 10 and 50 employees (shown in Table 4). Table 4 also revealed that almost half of the MSEs have their profits between ₦100,000 and ₦500,000, and majority (71.6%) of the businesses have been established between 2 and 10 years while only few (25%) of them have been in existence for more than 10 years.

Table 5 shows the correlation between willingness to adopt renewable energy sources and characteristics of the businesses/ owners. The result indicated that the correlation between willingness to adopt RE sources and highest academic qualification (0.48), nature of businesses (0.61), size of enterprise (0.38), age of enterprise (0.51) and location of business (0.52) are all significant at 10% level of significance and also have the same direction of relationship with one another. However, the correlation between willingness to adopt RE source and age of the owner of the enterprise (0.55) and monthly profit (-0.49) are not significant, though the correlation values are averagely high. Mattes et al. [34] and Shen et al. [43] also show that willingness to adopt RETs is correlated with size of enterprise, highest academic qualification, age of enterprise and location of business. The results of age of the owners of the enterprise and monthly income are against the findings of Ng'eno [27] and Shen et al. [43]. This implies that the age of the owner of the enterprise and the profits of the business have not made any statistical difference to the willingness of the MSEs to adopt RETs.

4.2 Factors influencing willingness to adopt renewable energy technologies by the micro and small enterprises

Table 6 presents an ordered logit regression results for the factors considered to influence willingness to adopt renewable energy technologies by the micro

Table 6: Factors influencing willingness to adopt renewable energy technology by MSEs

Variables	Descriptions	Coefficient	Odd-ratio
X_1	Knowledge and awareness about renewable energy technology	3.22**	25.03
X_2	Adequate government policies and standards for the production of renewable energy equipment and protection of consumers	2.41***	11.13
X_3	Development of renewable energy market that supplies the required accessories	0.68***	1.97
X_4	Participation of local residents in the planning and implementation process of renewable energy technologies	0.45	1.57
X_5	Previous experience of using renewable energy technology	-1.08	0.34
X_6	Trust in stakeholders who are responsible for the renewable energy technology (e.g. regulators or owners of the technology)	1.22**	3.39
X_7	If it makes life easier for me	0.90***	2.46
X_8	If it is simple to use and maintain	0.35***	1.42
X_9	If it improves job quality and standard of living	0.93***	2.53
X_{10}	Influence of other businesses in the area will encourage my enterprise to adopt renewable energy technologies	2.24*	9.39
MacFadden R-squared		0.46	

*p < 0.1
**p < 0.05
***p < 0.01

and small enterprises in Nigeria. Some of these factors are obtained from the relevant past studies conducted in other countries. While willingness to adopt renewable energy technologies (Y) is a dependent variable, the explanatory variables (X_n) are the 10 factors influencing willingness to adopt renewable energy technologies. The ordered logit regression results in Table 6 show that knowledge and awareness about renewable energy (X_1), government policies (X_2), renewable energy market (X_3), Trust (X_6), makes life easy (X_7), simple to use (X_8), improves job quality and standard of living and peer-group influence of nearby businesses (X_{10}) are all statistically significant to influence the willingness to adopt renewable energy technologies by the MSEs using 10% level of significance. The aforementioned variables also influence the likelihood of MSEs adopting RETs with odd ratios of 25.03, 11.13, 1.97, 0.39, 2.46, 1.42, 2.53, 9.39 for X_1, X_2, X_3, X_6, X_7, X_8, X_9 and X_{10} respectively.

Some of these results are in line with the study of Feng [14] on technology acceptance factors; Verbruggen et al. [33] on government policies; Shen et al. [43] on public awareness and renewable energy markets; and Huijts et al. [11] on trust and peer-effects. However, participation of local residents in the planning and implementation process (X_4) and previous experience in using renewable energy technologies (X_5) are not statistically significant in influencing the willingness of the MSEs to adopt renewable energy technologies in Nigeria. This means that previous experience of micro and small enterprises and the participation of local residents in the process of planning do not significantly impact on the MSEs adoption of RETs. MacFadden R^2 of 0.46 shows that the model is moderately fits.

Meanwhile, knowledge and awareness of renewable energy is the most influencing factor, followed by government policies, peer-group effect, trust, technology acceptance factors (improve job quality and standard of living, makes life easy and simple to use) and development of renewable energy market in Nigeria. There is need to create proper awareness of renewable energy among the businesses so as to enlighten the business owners more about it, which will later encourage them to adopt it in their enterprises.

Government should also encourage the use of renewable energy through different policies such as creating enabling environment for the easier production of renewable energy equipment and also protect consumers from substandard products. This will create a sustainable renewable energy markets where renewable energy products could be easily purchased. Many Nigerians have lost trust in government to actualise some of the policies made as a result of lack of political will. Thus, the government through relevant regulators and the private renewable energy companies should all play their roles

toward proper execution of renewable energy projects in the country so as to regain the citizens' trust, as it has been indicated in this study that trust influence the willingness to adopt RETs by the MSEs. The technology acceptance factors such as 'if the technology makes life easier', 'simple to use' and 'raising the standard of living', are all important to be perceived positively by the renewable energy users.

Furthermore, juxtaposing the general characteristics and the regression results where there had been insignificant relationship in the outcomes could be explained as follows. At first, willingness to accept innovation is always situational and real time experience. This is a reflection of the result obtained earlier in the literature [58]. It was reported that the cost priority and pay-back priority were the best decision-making criteria for choosing the best renewable building-integrated power production units. In this case, the cost priority indicates the present scenario and while the pay-back option analysis the future. Emphasis are not always dwell on the past especially when it is not negative. The decision to invest is always based on the present situation predicting the future for micro and small firms in particular.

The result may also reflect a compliment to their level of education (Table 2) as the study composition indicates clearly that above 70 percent of the respondents have already earned a bachelor degree. This might be an implication that they are well informed, and possessed the ability to assess and process information (tangible and intangible benefit accrue to the use of renewable technologies) toward making decision in line with the adoption of a renewable energy. In addition, the age of the owners which is centred around 26-40 years old as well as the age of the enterprise predominantly within 5 years of establishment (about 75 percent) show that majority of MSEs are within the age limits where adventures and risks can be experimented on new technologies so far it will give them a competitive advantage. According to studies the prices of solar energy technologies have been on a decreasing trend [55, 56] to an extent that prices of the panels had declined by 65 per cent in the 5 years up to 2014 [57]. The prices are more or less at par with the subsidized petroleum products thereby refuting the emphasis on the long-term breakeven and benefits of renewable energy technologies to a moderate term.

Secondly, the outcome of participation of local residents in the planning and implementation process of renewable energy technologies was insignificant. This particular variable is largely stimulated by the lack of political will and carefree attitude of the government on the formulation, planning and implementation of the energy policies. Most of the time proper attention are not paid to the composition of the stakeholders on policy formulation. The compositions are mostly bias in favour of the pro-government. Therefore, the practitioners do not feel their input in the final policy document which makes its implementation difficult. In most cases, the energy policy documents are not updated in time nor review which culminate into it being outdated. It may also be reasonable to say that most of the developing countries, and in particular Nigeria, do not initiate the changes in technological advancement but are rather imported into their spaces. These are more disruptive requiring different learning, skills and application in a country where lack of planning and worrisome implementation is predominant. The result is insightful and prove the reason why the country needs to provide more enabling environment to increase the level of absorptive capacity in the renewable energy technologies.

5. Conclusion

It is well documented that renewable energy has been found to be an alternative to the currently dominated fossil fuel across the globe. While many developed and emerging countries are fully integrating renewable energy into their national grid system, most developing countries still lag behind. Since micro and small enterprises occupied a large proportion of the Nigerian economy, this study therefore examined the factors influencing willingness to adopt renewable energy technologies. Theory of reasoned action and technology acceptance model were adapted in evaluating some of the factors influencing willingness to adopt RETs. Correlation was established between willingness to adopt RETs and highest academic qualification, nature of businesses, size of enterprise, age of enterprise and location of business.

Furthermore, the factors that have been established in this study to significantly influence willingness of MSEs to adopt RETs are knowledge and awareness about renewable energy, government policies, renewable energy market, trust, peer-group influence of nearby businesses and technology acceptance factors (such as the technology makes life easy, simple to use, improves job quality and standard of living). The adoption and efficient implementation of renewable energy in Nigeria is expected

to increase if the factors measured to be statistically significant in this study are given utmost consideration. Both the private enterprise and relevant government need to cooperate so that each plays its roles towards improving the adoption of renewable energy technologies.

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