

Effect of renewable energy development on sustainable development of small and medium enterprises potentials in Nigeria

Umar Gunu Suleiman

Department of Business Administration, Federal Polytechnic, Nasarawa, Nasarawa State, Nigeria.

Email: gunu4kaiaama@gmail.com; Tel: +2348037631115, +2348024442871.

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ABSTRACT: The effect of renewable energy (RE) development on the sustainable development of SMEs' potential in Nigeria was empirically done to unlock the possibility of deciphering the perennial energy problem in Nigeria. The development of renewable energy (RE) resources and utilization can greatly benefit Small and Medium Enterprises (SMEs) in Nigeria by providing a reliable, sustainable and cost-effective power supply. This is especially important, as many sectors of Nigeria's economy, including SMEs, are highly dependent on the poor power supply that is currently available. Thus, this study specifically examines the effect of RE resources availability, generation, system efficiency and effectiveness, and utilization on SMEs' sustainable development potential in Nigeria. A survey research design was adopted and a population of 73,081 SMEs across Nigeria was utilized with a sample of 398 SMEs selected using multi-stage sampling techniques. A validated questionnaire was administered to the owners/managers of the selected SMEs, information obtained from the questionnaire was collated, scrutinized, and analyzed using Structural Equation Model (SEM) with the aid of SMART PLS 4 software through the structural model. The findings revealed that RE resources availability, generation, system efficiency and effectiveness, and utilization potentials of SMEs have a positive and significant effect on the potential development of SMEs in Nigeria. The study concluded that RE resources availability, generation, system efficiency and effectiveness, and utilization have significant influence on SMEs' sustainable development potential in Nigeria. Thus, government, private sectors, and international development partners should focus on providing more resources, knowledge, and support to enable SMEs to access, generate and effectively use renewable energy resources more efficiently.

Keywords: Nigeria, renewable energy, small and medium enterprises, sustainable development.

INTRODUCTION

Small and Medium Scale Enterprises (SMEs) are critical and major drivers of economics worldwide. They are major contributors to the Gross Domestic Product (GDP), employment generation, utilization of local resources, improved standard of living, and stimulation of creativity, innovation and competition in many developed nations. They are also impeccable for assisting big businesses in the supply of inputs, provision of services, distribution of products, and provision of information. They are described as engines of economic growth due to the amount of revenue they are generating (Etuk *et al.*, 2014). According

to Gbandi and Amissah (2014), in Nigeria, SMEs are seen as catalysts in its economic development, helping to generate employment, improve local technology, diversify output, develop indigenous entrepreneurship, and improve forward integration with large-scale industries. Therefore, creating enabling environment including the provision of a sufficient and dependable energy supply for SMEs is desirable, particularly with the increased growth in economic activities. As one of the fastest growing economies in Africa due to the explosive economic activities that increased energy demand, Nigeria needs

more energy sources that are costless and harmless to meet-up with demand. Without a strong focus on energy efficiency, economic development cannot attain its full potential. Power, energy, or electricity is the defining characteristic and lubricant of development, and without enough energy, it is impossible for any society to develop sustainably. All human endeavours, including business, require high quality and enough energy to be successful. Energy is a vital component of all economic activity and serves as a foundation for wealth creation and the engine of growth for all economic sectors (Ayodele, 2004). Nigeria is heavily reliant on hydro and non-renewable energy sources to power its economic activity and fuel business growth. This is despite the fact that Nigeria is endowed with abundant energy resources, both renewable and non-renewable. The lack of access to reliable energy has become a major obstacle to the long-term growth and development of all economic sectors in the country. To counter this, the government has taken deliberate steps to create an environment conducive to the flourishing of small and medium enterprises (SMEs). This includes providing them with consistent and dependable access to electricity. However, despite these efforts, the country still lags behind in terms of energy access and utilization. This is due to the inefficient utilization of existing energy resources, weak infrastructure and policy implementation, and inadequate financing of renewable energy projects. According to Onakoya *et al.* (2013), efficient access to reliable energy is a key factor in the long-term growth and development of all economic sectors of a country. Therefore, to ensure effective and sustainable economic growth, the government must take decisive steps to optimize the utilization of these resources, strengthen the energy infrastructure, and provide necessary funding for renewable energy projects. This will ensure that all economic sectors have the energy they need to continue to grow and prosper.

Renewable energy (RE) has become an increasingly important source of power around the world, and its development is essential for many to meet their energy needs. RE is dependable, costless and more beneficial for SMEs than costly (transportation cost), inconvenient, insufficient, unreliable, pollutant-prone, and limited fossil energy. Thus, the development of RE by public and private institutions including SMEs is essential and germane to meet the country's power needs. Cost-effectiveness, non-exhaustibility, environmental friendliness, sustainable development and growth, reduction in the dependency on depleting fossil fuels, and minimizing the greenhouse gas emission rate of the country are some of the profits of developing and utilizing RE (Osunoyomi, 2013). In Nigeria, the sources of RE are solar, biogas, wind energy and hydropower which helps to contribute to the sustainable development and the growth of small and medium enterprises (SMEs) (Chilakpu *et al.*, 2018; Charles, 2014; Osunoyomi, 2013). The hydro potential is exemplified by rivers dispersed across the country (e.g. Shiroro, Makurdi,

Ikom and Mambilla) with a total capacity of 18,000 MW to 20,600 MW of power; wind energy is enormous due to wind speeds of as high as 8.70 m/s in the north; solar energy is huge due to solar radiation of an average of 6 hours per day capable of producing between 3.5 and 7.0 kW/m/day; and high biomass energy due to biomass of over 227,500 tons of fresh animal waste alone per day capable of generating roughly 6.8 million m³ of biogas per day (Uzoma *et al.*, 2011; Charles, 2014). Similarly, because of Nigeria's strategic location, it benefits from hydropower generation, having access to an 840-kilometre coastline in the south and two major rivers flowing from the northeast and northwest; and because of its proximity to the Sahara, it receives enough sunshine and has moderate breezes to generate significant power (RE Master Plan, REMP 2005; Charles, 2014; Udochukwu, 2014; Chilakpu *et al.*, 2018). Although, among all sources of RE, only hydropower resources are sustainably and currently exploited and connected to the national grid while woody biomass (Fuel wood) is the main energy source for rural communities for centuries (Akinbami in Osunoyomi, 2013).

Despite these immense opportunities, energy generation and accessibility are still facing unembellished challenges. Evident shows that about 40% of Nigeria's population is connected to the energy grid mostly from hydro whilst power supply difficulties are experienced around 60 to 70% of the supply time with an average daily power supply of four hours at best (Aliyu *et al.*, 2013; PWC, 2016; Sabo and Lekan, 2019). Every sector and section of the country lacks access to sufficient energy or power supply which does not only distort and crippled business operations but also absorbed a huge part of the business expenses. Gado and Obumneke (2015) asserted that the lack of stable and adequate electricity is among the leading problem hindering the growth and development of businesses including SMEs in Nigeria. SMEs spend two to three times more on self-generation of energy (fossil fuel mainly) and this increases operating costs limiting their ability to meet many objectives including growth and development. Other limitations include inefficiency, noise and fumes, spillage and contamination of land, frequent maintenance, and difficulty in the replacement of parts, among others.

Small and medium-sized enterprises (SMEs) in Nigeria are hindered from taking full advantage of renewable energy (RE) sources due to a variety of challenges. These include the difficulty of identifying available RE resources, understanding the technicalities of generation, utilization issues, and an inefficient and ineffective system. It is not just SMEs that suffer from these difficulties, but because of their size, organizational structure, and financial limitations, the obstacles can be more severe for SMEs (Onakoya *et al.*, 2013; Ibe and Nbudubisi, 2019). Therefore, to better understand the potential benefit that awaits SMEs and other businesses through the development of power by RE resources, empirical

investigations are needed to shed light on the topic. Thus, the aforementioned problem of the study has the following research questions outlined for empirical solutions:

1. What is the effect of RE resources availability on the SMEs' sustainable development potentials in Nigeria?
2. How does RE generation impact SMEs' sustainable development potential in Nigeria?
3. What is the impact of RE system efficiency and effectiveness on SMEs' sustainable development potential in Nigeria?
4. How does RE utilization affect SMEs' sustainable development potential in Nigeria?

LITERATURE REVIEW

Conceptual framework

Renewable Energy (ER) Development

Renewable energy (RE) is an increasingly popular form of energy that is replenished naturally at a rate that is comparable to or faster than the rate of human consumption. RE is sourced from natural energy sources like solar radiation, tides, winds and hydroelectricity that are in no danger of long-term availability with a sustainable yield, unlike fossil fuels like gasoline, coal, natural gas, diesel, and other commodities (Chel and Kaushik, 2011). Technology advancement has made the development and utilization of renewable energy technologies easy and applicable in the consumption of primary energy resources that are not subject to depletion. Additionally, to increase energy security, safeguard the environment, and promote economic progress, renewable energy (RE) is increasingly becoming the norm (Benedek *et al.*, 2018). RE is a form of energy that is replenished naturally and emanates from natural energy sources such as sunlight, rain, geothermal heat, wind, wave, geothermal, tidal, biomass, and hydropower reservoirs (Tijjani *et al.*, 2013; Ellabban *et al.*, 2014; Surya *et al.*, 2021; Yu-Xia *et al.*, 2022). Renewable energy can never run and can be used again and again. Renewable energy has been in use for so many years in different ways. An example is how the primordial human used the application of wind for sailing; rather the same wind is now used for electricity generation in the modern era (Daramola, 2012). The potential benefits of utilizing RE are cost effectiveness, non-exhaustibility, environmental friendliness. It can also reduce dependency on depleting fossil fuels, and additionally, when used properly, it can reduce greenhouse gas emissions (Osunoyomi, 2013).

The transformation of the global economy to sustainable development is greatly aided by RE (Yu-Xia *et al.*, 2022). Given the negative impact of fossil fuels on the environment, significant fluctuations in their prices, and the lack of relevant resources in many countries around the world (due to excessive dependence on imports), RE is a

quality alternative. In addition, RE technology can increase economic resilience and energy stability via supply diversification (Yu-Xia *et al.*, 2022). Governments and private organizations have begun to invest heavily in RE initiatives, because RE has become a top priority in recent years due to its ability to reduce greenhouse gas emissions, create jobs, reduce dependence on non-renewable energy sources, and increase energy security. The United Nations (UN) Sustainable Energy for All (SE4All) initiative of 2012 focuses on energy policy and mobilizes action towards achieving universal access to modern energy services by 2030. And more recent studies argued for the development of appropriate technologies (wind, solar, and water energy) to transform local societies into energy-independent organizations, which can take the form of energy-independent villages with RE as the centre (Benedek *et al.*, 2018).

The enormous potential Nigeria possesses in the area of renewable energy is surprisingly alluring. Due to its strategic location, which gives it access to 840 km of southern coastline and two large rivers that come from the northeast and northwest, it is blessed with the ability to generate hydropower. Its proximity to the Sahara offers sufficient sunlight and moderate breezes for significant power output (Charles, 2014; Renewable Energy Master Plan, REMP, 2005; Udochukwu 2014). According to Charles (2014) and Osunoyomi (2013), Nigeria has a variety of renewable energy sources, including water resources (hydropower), wind resources (wind energy), solar resources (solar energy), and biomass energy (animal, fuel wood, agricultural and wood residues, fuel wood) with the potential of solving the current energy challenges if exploited. First, Nigeria is blessed with an abundance of water resources that may be used to generate hydropower, which is energy produced by mechanically converting energy into electricity through a turbine at a typically high-efficiency rate (Charles, 2014). Presently, hydropower accounts for just around 19% of all installed commercial electric power capacity in Nigeria, although having a large-scale potential (exploitable) of more than 18,600 MW (Zarma, 2006). Second, numerous research indicates that Nigeria has good wind energy potential with the North having the best strategic location (Ajayi, 2010). Without any commercial connectivity to the national grid, the contribution of wind energy to the country's current energy usage is regrettably low (Charles, 2014). Third, due to Nigeria's geographic location in the equatorial region, the nation receives a full and abundant amount of solar radiation that is evenly distributed throughout the country, resulting in an average of 6 hours of sunshine per day, with sunshine ranging from about 3.5 hours at the coastline to 9.0 hours at the far northern boundary (Vincent-Akpu, 2012). With an average daily sunshine duration of 4 to 7 hours, Nigeria can produce between 3.5 and 7.0 kW/m/day, which is more than one hundred times the country's current grid energy consumption level (Uzoma *et al.*, 2011). The majority of

Nigerians (rural residents and small and medium-sized companies) might create solar energy through the roof and build integrated designs, boosting electricity decentralization and access where individuals purchase, use, and apply the system's energy via the solar system. Fourthly, biomass comes in solid (like straw or wood chips), liquid (such as vegetable oils and animal slurries that can be converted to biogas), and gaseous (biogas) forms. It is obtained from forestry, agricultural, and municipal leftovers as well as a small portion of crops planted primarily for fuel (Renewable Global Status Report, 2010; Uzoma *et al.*, 2011). It is frequently burned to produce power and heat and is then transformed into biofuels for transportation (Renewable Global Status Report, 2010). Although the most promising crops for biofuel production are sweet sorghum, maize, and sugarcane, plant biomass can also be used as fuel for small-scale industries and can be fermented by anaerobic bacteria of water lettuce, water hyacinth, dung, cassava leaves, processing waste, urban refuse, solid (including industrial) waste, agricultural residues, and sewage to produce a cheap fuel gas (biogases) (Charles, 2014). In addition to not competing with food crops like bioethanol and biodiesel production for resources like land, water, and fertilizers, the production of biogas also lessens the risks caused by these wastes. According to estimates, Nigeria generates approximately 227,500 tonnes of fresh animal waste each day and is capable of producing 6.8 million m³ of biogas each day using solely animal waste (1 kilogramme of fresh animal waste creates approximately 0.03 m³ of biogas) (Charles, 2014).

Sustainable Development of SMEs

The definition of SMEs is diverse depending on the countries, authors, scholars, agencies and many conditions. Thus, there is no generally accepted definition or classification of SMEs. Different authors, scholars and schools have different ideas as to differences in terms of capital outlay, number of employees, sales turnover, fixed capital investment, available plant and machinery, market share, and the level of development (Ogechukwu, 2009 in Gbandi and Amisah, 2014). The most common definitions and classifications of SMEs in Nigeria are based on certain criteria including capital employed, turnover, employees' size, profit, available finance, market share, and relative size within the industry (Gbandi and Amisah, 2014). The Central Bank of Nigeria (CBN) through its various programs defined SMEs as entities with an asset base of N5 million and not more than N500 million excluding land and buildings with employees between 11 and 200 (Highnet, 2020). Small and Medium Enterprises Credit Guarantee Scheme (SMECGS) states that an enterprise that has an asset base (excluding land) of between N5 to N500 million and a labour force of between 11 and 300 belongs to the SME sub-sector (Gbandi and Amisah,

2014). The National Council of Industry categorized enterprises based on three criteria: size, number of employees and total cost (including working capital but excluding land). It said Microenterprise has 1-10 employees, less than 1 Million Naira total cost; Small has 11-35 employees, 1 Million Naira to less than 40 Million Naira total cost; Medium has 36-100 employees, 40 Million Naira to less than 200 Million Naira total cost; Large has 101 employees and above, 200 Million Naira and above total cost (Etuk *et al.*, 2014). The European Union adopted a universally accepted definition of SMEs as companies with less than 250 employees, revenues must not exceed 50 million euros (turnover) or 43million euros and went further to break down the SME into micro (less than 10 employees, small (from 10 to 49 employees) and medium (between 50 to 249 employees) (Fatai, 2011 in Gbandi and Amisah, 2014; Etuk *et al.*, 2014). SMEs are businesses with a turnover of less than N100 M per annum and/ or less than 300 employees (Oyeyinka, 2020). Thus, SMEs across the globe share certain characteristics including the same ownership and management, owners and employees close relationship, active participation of owners in decision making, low to medium skills workforce, low to medium assets, low to a medium number of employees, local to medium operation, low to medium capital intensive industries, and high in number among enterprises. SMEs are very crucial to the economic development of any nation. They make substantial contributions to the economy through many channels. For example, small-scale enterprises are known to make about 55% of GDP and 65% of employment in high-income countries but their economic contribution in Nigeria falls below expectations due largely to the harsh economic environment (Osotimehin *et al.*, 2012 cited in Ado, 2015). The shallow infrastructure base of the economy means that SMEs just like other businesses face serious operational challenges and must have to provide for most of their infrastructure needs if they have to optimize their operations (Ado, 2015).

Sustainable development is defined as development that meets the needs of the present without compromising the ability of future generations to meet their own needs (IISD, 2020). It is a development that satisfies the present needs of the people without compromising the capacity of future generations, guaranteeing the balance between economic growth, care for the environment and social well-being (Acciona, 2020). It is the organizing principle for meeting human development goals while simultaneously sustaining the ability of natural systems to provide the natural resources and ecosystem services on which the economy and society depend. The concept was initially coined for environmental concerns but was shifted towards economic development, social development, and environmental protection for the future generation. Today, sustainability is the foundation for the leading global framework for international cooperation called "the 2030 Agenda for Sustainable Development" through the

seventeen Sustainable Development Goals (17 SDGs) with the universal application (IISD, 2020). Therefore, SMEs' sustainable development is the development of SMEs that meets the present needs as well as the future needs of the people and the environment. Thus, the growth and expansion of SMEs that will drive economic development, social development and environmental protection for future generations is behind the concept of sustainability (sustainable development) of SMEs.

Theoretical framework

Development theories such as modernization, dependency, globalization, and world system theories and SMEs performance theories including the BSC, Performance Prism, System Theory and ABC approach are appropriate for explaining a shift from non-renewable energy to RE development for sustainable development of SMEs. Thus, Modernization Theory (MT) and ABC approach are adopted because the process involved a transition from a traditional to an innovative method of energy generation and utilization and a cost-effective method of management business. MT is rooted in the views of German sociologist Max Weber (1864–1920), which acted as the framework for Harvard sociologist, Talcott Parsons' (1902–1979) modernization paradigm. It is believed that traditional nations can advance in similar ways as industrialized nations with necessary aid (Gavrov and Klyukanov, 2015). The theory describes the process of social evolution and the social factors that influence growth and development. MT not only highlights the changing process, but also emphasizes the responses to that change by taking into account internal dynamics, social and cultural institutions, and the adoption of new technologies. Hence, advancements in data technology and the upgrading of transportation, communication, and industrial processes make modernization preferable to the status quo. As per the notion, traditional religious beliefs and cultural features of the old ways of doing things become less relevant as modernity persists via reform and innovation (Gavrov and Klyukanov, 2015). Using fossil fuel to generate electricity as an alternate source of energy is becoming outdated. Utilization of RE is the new paradigm (the modern way) of providing alternative power supply to businesses including SMEs. Similarly, the ABC approach is utilized to access the cost of a resource utilized for organizational activities and then connect every activity to the costs of its output.

Empirical review

Osunyomi (2013) studied the potential of RE for the sustainable expansion of Nigeria's agricultural sector and economic growth by identifying the potential of the RE sector in Nigeria's agricultural sector's growth and development. Qualitative literature review of existing

published materials was utilized and it was concluded that productive exploitation of the RE potentials possesses the ability to aid the sustainable development of the primary economic sectors, the reduction of the adverse impact of climate change, and the economic growth of Nigeria. Being a qualitative investigation that is based on a literature review and a study in the agriculture sector limited the application. Ibe and Obodoechi's (2019) study was determined to develop a broader understanding of identifying the energy/SME conservations towards the growth of Nigerian GDP. The finding reveals that improving the implementation of energy efficiency measures by SMEs could lead to substantial energy savings, significant positive economic benefits, advances in productivity, competitiveness and resilience, and better social and environmental benefits. The study utilized content analysis of relevant empirical studies which has limited its application. Gado and Obumneke (2015) utilized Ordinary Least Square (OLS) multiple regression method, unit root test and co-integration to analyze the effects of electricity on the growth of SMEs in Nigeria between 1990 and 2013. The result indicates that an erratic power supply led to a decline in SMEs' growth. Sample size, variables used and timing are factors that drive the need for another study. Ado and Josiah (2015) investigated the impact of deficient electric power supply on the operations of SMEs operating in the northeast of Nigeria by using a stratified random sample, questionnaire, and regression analysis. Results indicate that there is a poor supply of electricity leading to high operational costs for SMEs. Utilizing diverse variables, a wider sample, and a robust statistical tool to project SME development drives is required.

The opportunities involved in the use of RE for agriculture including energy efficiency and self-sufficiency and its challenges such as the difficulty in obtaining accurate data in undeveloped and developing nations were investigated. Factors like the high costs of initial investments in RE startups, lack of technical skills in installation and maintenance, lack of societal awareness of the benefits of RE, and lack of incentives to encourage agriculturists and other stakeholders to its utilization are identified by the study as challenges facing RE. The conclusion is that RE guarantees clean energy for farming, improves energy efficiency, and saves energy and finances (Babatunde *et al.*, 2019). However, poor methodology and lack of a clear sample are issues of concern that drive further study. The study on the role of RE in farming by connecting all aspects of agronomy with ecology, environment, economics and societal change discovered that RE is efficient, feasible, suitable for the environment, and has the potential for sustainable agricultural development (Chel and Kaushik, 2011). However, the study is not empirical and does not give the desired coverage. Olatunji (2019) studied the effect of electricity insecurity on the performance of SMEs in the Akoko area of Ondo State, Nigeria. Using a descriptive research design and multiple regression techniques, results revealed that capacity, duration, and reliability of

electricity supply have a significant positive relationship with the performance of SMEs. However, the cost and quality of electricity supply have no relationship with the performance of SMEs. It was concluded that a stable electricity supply is needed to promote the growth of SMEs. The limited study area and the methodology used called for further research with a robust methodology. Sabo and Lekan (2019) examined the effect of firm characteristics in the energy-business growth relationships using the quantitative methodology, questionnaire data from 197 SMEs operating in the city of Kano, Katsina and Jigawa state, Nigeria, and a multiple linear regression model. The result shows that there is a strong positive relationship between SMEs' growth, electricity supply, firm age, firm size, and leverage. Further study is required to determine the extent and direction of the relationship with multiple related variables of RE and a robust statistical tool such as the Partial Least Squares (PLS) of Structural Equation Modelling (SEM). Oduyoye *et al.* (2013) evaluated the infrastructure support activities of the Small and Medium Enterprises Development Agency of Nigeria (SMEDAN) in her bid to ensure the growth of cooperative-financed SMEs in Ogun State, Nigeria between 2005 and 2010. Using 135 questionnaires and descriptive statistics, the study revealed that the provision of Infrastructure Support by the SMEDAN was not significant to the growth of some selected businesses (especially cooperative-financed SMEs). However, studying infrastructure generally and using descriptive statistics called for a more specific, robust, and empirical study on RE and SMEs.

METHODOLOGY

A survey research design was adopted and the population comprises all registered SMEs in Nigeria. The National Bureau of Statistics (NBS) survey of Micro, Small and Medium Enterprises (MSMEs) reported that the total number of MSMEs as of December 2017 stood at 41,543,028, with components as follows: Micro Enterprises (MEs): 41, 469,947 (or 99.8 per cent), and SMEs: 73,081 (or 0.2 per cent) (NBS, 2022). Based on the above, the population is 73,081 registered SMEs across the 36 states in Nigeria and federal capital territory. The sample was drawn by using multi-stage sampling techniques which comprise of stratified, purposive and availability. Taro Yamane's formula (1967) of $n = \frac{N}{1+N(e)^2}$... (1) was utilized to determine the appropriate sample size at a 5% error level. Where: n = sample size, N = population size and e = level of precision or error which is taken as 5% (0.05).

$$\text{Therefore: } n = \frac{73081}{1+73,081(0.05)^2} \quad n = \frac{73081}{1+182.7}$$

$$n = \frac{73081}{183.7} \quad n = 397.8$$

Thus, the sample size for the study is 398 SMEs.

A representation was selected from the 36 states and FCT through SMEDAN. Through the use of questionnaires, the agency was able to collect the relevant data from the owners and managers of the SMEs. The scale of responses on the questionnaire is as follows: strongly Agree, Agree, Undecided, Disagree to Strongly Disagree (Likert Scale) which is calibrated and scored 5, 4, 3, 2, and 1. To ensure that the instrument measures exactly what it is intended to measure, the questions structured were comprehensive, relevant, and unambiguous. Thus, a total of 450 copies of the validated questionnaire with Cronbach's Alpha of 0.82 were administered by the researchers with the aid of research assistants (SMEDAN). Only 417 copies of the questionnaire were collected of which 398 copies were utilized based on the study sample size. Information obtained from the questionnaire was collated, scrutinized, and analyzed using Structural Equation Model (SEM) with the aid of SMART PLS 4 software through the structural model below (Figure 1).

Figure 1 shows the path model analysis of the RE development influence on SMEs' sustainable development potentials. Four structural paths are hypothesized, namely, RE Availability (REA) effect on SMEs' Sustainable Development potentials (SME-SD), RE Generation (REG) effect on SME-SD, RE Utilization (REU) effect on SME-SD, and RE system efficiency or RE Efficiency and effectiveness (RESE) effect on SME-SD. These represent the four research questions and hypotheses the study validated.

RESULTS AND DISCUSSION

Measurement model

The issue of reliability and validity has momentous implications on the result of any investigation. Thus, worthy research must be free from issues of reliability and validity. Smart-PLS used in this investigation deal with both the measurement model and structural model at once. The measurement model was carried out to ensure that the data collected are consistent (reliable) and accurate (valid). Reliability was done through internal consistency (Cronbach's alpha, and composite reliability) while validity was done with convergent validity (indicator reliability and AVE), and discriminant validity.

Table 1 shows that the values for Cronbach's alpha and the composite reliability of all the constructs under investigation are more than the minimum standard of 0.70 confirming the reliability of the data. Apart from convergent validity, discriminant validity is also used to determine the validity or accuracy of the constructs. Fornell-Larcker Criterion (Table 2), Cross Loadings (Table 3), and Heterotrait-Monotrait Ratio (HDMT) (Table 4) are used to determine discriminant validity.

Table 2 exhibits the Fornell-Larcker criterion used to check the discriminant validity. Thus, the correlations

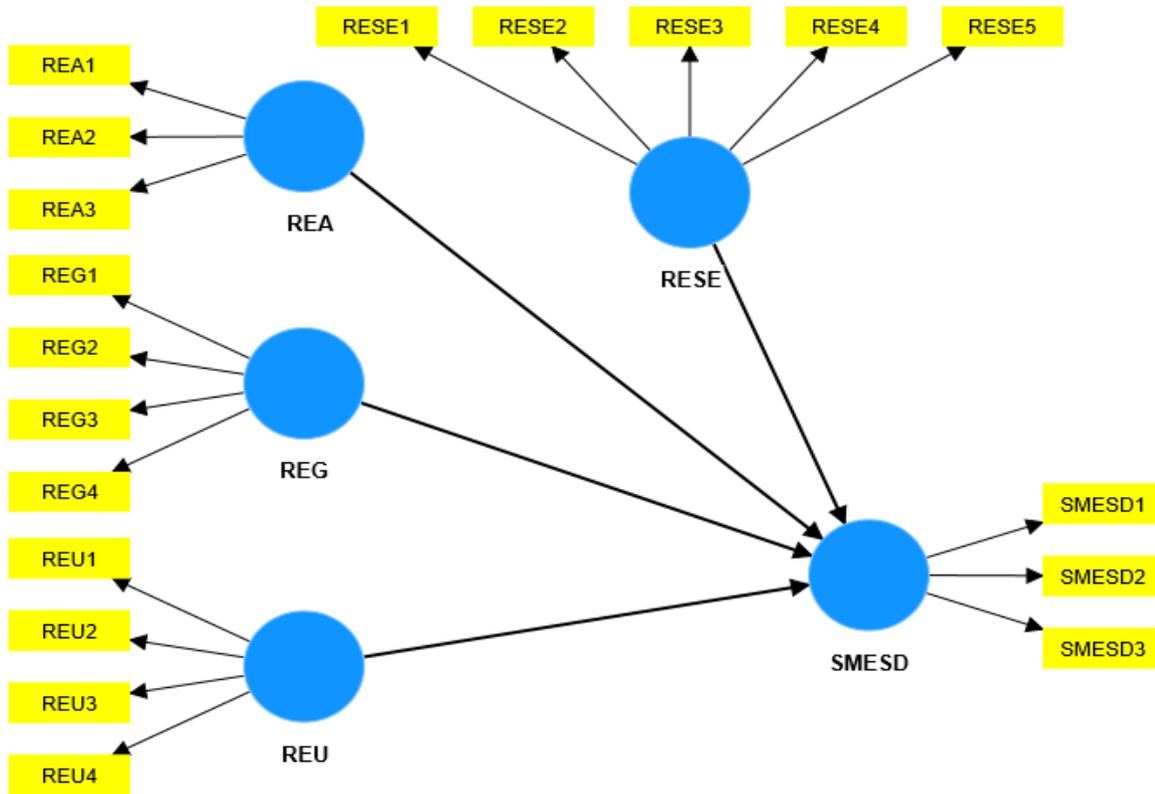


Figure 1. Constructs Hypothesized Structural Model (Source: Author’s calculation from SmartPLS 4, 2023).

Table 1. Reliability and discriminant validity.

Parameters	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	The average variance extracted (AVE)
RE Availability	0.81	0.87	0.89	0.72
RE Generation	0.79	0.81	0.86	0.61
RE System Efficiency	0.86	0.88	0.90	0.64
RE Utilization	0.80	0.85	0.87	0.63
SME Sustainable Development	0.83	0.83	0.90	0.74

Source: Author’s SmartPLS 4 Output, 2023.

Table 2. Discriminant validity: Fornell-Larcker Criterion.

	RE Availability	RE Generation	RE System Efficiency	RE Utilization	SME Sustainable Development
RE Availability	0.85				
RE Generation	0.84	0.78			
RE System Efficiency	0.75	0.75	0.84		
RE Utilization	0.45	0.61	0.77	0.79	
SME Sustainable Development	0.78	0.79	0.83	0.77	0.86

Source: Author’s SmartPLS 4 Output, 2023.

between each pair of constructs were checked to ensure they did not exceed the square root of the AVE of each of the constructs. The result indicates that all the values (in bold) of the square root of the AVE of each construct are

more than the correlated values below them. Therefore, the discriminant reliability of the construct is established.

Table 3 presents the result of the constructs cross-loading. In this approach, an indicator's outer loading on

Table 3. Discriminant validity: Cross Loadings.

Parameter	RE Availability	RE Generation	RE System Efficiency	RE Utilization	SME Sustainable Development
REA1	0.68	0.39	0.44	0.18	0.44
REA2	0.94	0.76	0.69	0.40	0.72
REA3	0.90	0.88	0.74	0.51	0.78
REG1	0.73	0.74	0.53	0.18	0.51
REG2	0.56	0.80	0.69	0.69	0.70
REG3	0.78	0.82	0.52	0.48	0.72
REG4	0.53	0.78	0.61	0.47	0.48
RESE1	0.56	0.54	0.88	0.62	0.73
RESE2	0.53	0.55	0.87	0.75	0.81
RESE3	0.29	0.33	0.67	0.63	0.48
RESE4	0.79	0.75	0.80	0.63	0.63
RESE5	0.82	0.83	0.78	0.45	0.63
REU1	0.37	0.62	0.62	0.80	0.61
REU2	0.47	0.53	0.67	0.89	0.78
REU3	0.38	0.54	0.71	0.72	0.54
REU4	0.12	0.14	0.39	0.74	0.42
SMESD1	0.57	0.69	0.63	0.77	0.81
SMESD2	0.72	0.62	0.74	0.59	0.86
SMESD3	0.72	0.73	0.78	0.63	0.92

Source: Author's SmartPLS 4 Output, 2023.

Table 4. Discriminant validity: Heterotrait-Monotrait Ratio (HDMT).

	RE Availability	RE Generation	RE System Efficiency	RE Utilization	SME Sustainable Development
RE Availability					
RE Generation	0.99				
RE System Efficiency	0.88	0.91			
RE Utilization	0.51	0.74	0.91		
SME Sustainable Development	0.93	0.96	0.97	0.91	

Source: Author's SmartPLS 4 Output, 2023.

the associated construct should be greater than all of its loadings on other constructs (i.e., the cross-loadings)" (Hair *et al.*, 2016). Thus, all indicators' outer loadings on their associated constructs are greater than their cross-loadings confirming discriminant validity.

HDMT discriminant validity states that the values of the constructs should be less than 0.95. The values in Table 4 indicate that all the values are less than 0.95 except the values of 0.99, 0.96, and 0.97 for REA/REG, REG/SME-SD, and RESE/SME-SD respectively. Since the differences are insignificant and HDMT and cross-loading are valid, discriminant validity is established.

Path model

This involves the evaluation of the structural model by testing collinearity among constructs and assessing the

significance and relevance of hypothesized relationships. The path model of the variables is shown Figure 2.

Figure 2 shows the path model analysis between the exogenous constructs (REA, REG, REU, and RESE) and the endogenous constructs (SME-SD). The figure presents interaction effects where more than one variable contribute to the latent constructs.

Before carrying out the path analysis and hypotheses testing, collinearity between each of the variable is checked. Variance Inflation Factor (VIF) is frequently utilized to detect collinearity with a maximum value of 5.00 (Hair *et al.*, 2014). Table 5 indicates that all the VIF values are below 5, indicating the absence of collinearity among predictors.

The most widely known estimation used to assess a model is the coefficient of determination, R square (R^2), which measures the model's exactness and predictive capacity (Hair *et al.* 2014). The R^2 value of 0.83 (Table 6)

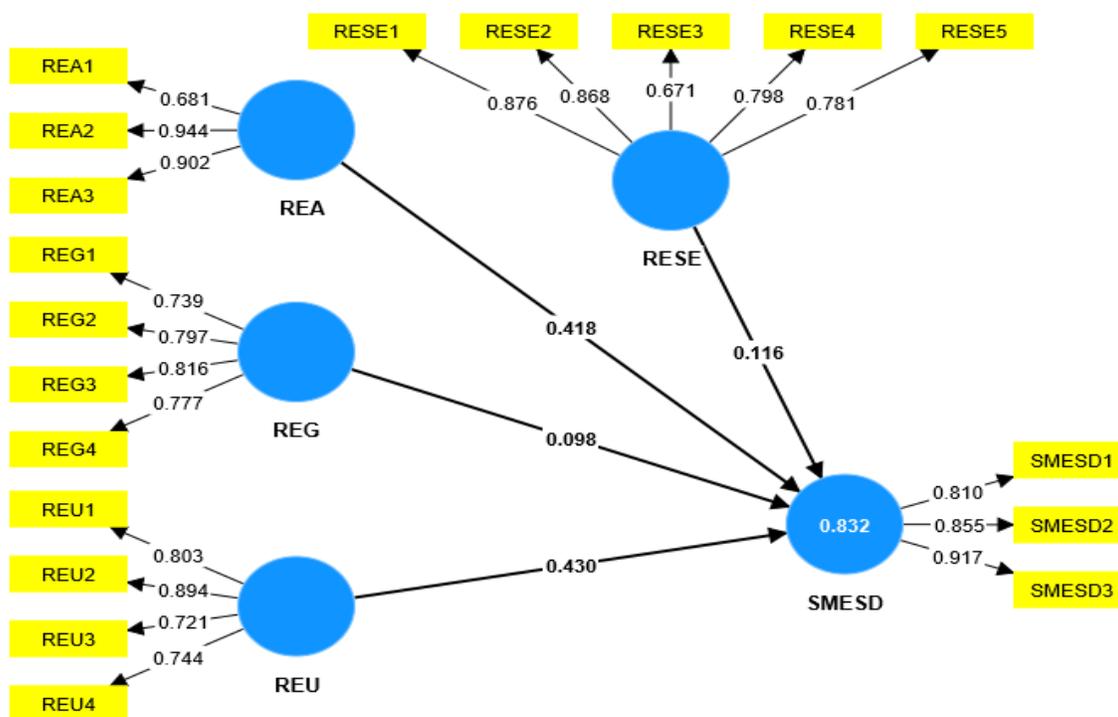


Figure 2. RE development and utilization and SMEs Sustainable development path model (Source: Researchers' Path Model, 2023).

Table 5. Variance Inflation Factor (VIF).

Parameters	VIF
REA1	1.51
REA2	3.49
REA3	2.76
REG1	1.54
REG2	1.67
REG3	1.71
REG4	1.80
RESE1	3.50
RESE2	3.44
RESE3	1.74
RESE4	3.32
RESE5	3.32
REU1	1.65
REU2	2.47
REU3	1.47
REU4	1.93
SMESD1	1.63
SMESD2	2.21
SMESD3	2.80

Source: Author's SmartPLS 4 Output, 2023.

fluctuation of the dependent construct (SME-SD). The remaining 17% is explained by factors not captured in the model. Since the value is above the threshold level of 0.20, the study can conclude that the dependent construct can be explained by the connected predictor constructs in the model with a very good predictive capacity.

Table 7 shows the path coefficients, T-values and P-values of the model. The coefficient of 0.42, 0.10, 0.12, and 0.43 indicate that every one unit change in REA, REG, REU and RESE will cause SME-SD to increase by 42, 10, 12 and 43%, respectively. The T-values of 12.44, 3.41, 3.14, and 13.89 (which are above the standard of 1.96) with corresponding p-values of 0.000, 0.001, 0.002 and 0.000 which are below the significance level of 0.5 validate the hypotheses. Thus, the study rejects all four hypotheses, thus, RE availability, RE generation, RE system efficiency, and RE utilization have a significant effect on SMEs' sustainable development potentials in Nigeria.

Based on the results, it was established that RE availability has the potential to promote the sustainable development potential of SMEs in Nigeria. This is consistent with the finding of Osunyomi (2013) that productive exploitation of the RE potentials can aid the sustainable development of the primary economic sectors including SMEs. Also, finding indicated that RE generation can influence SMEs sustainable development in Nigeria. This is in line with the finding of Olatunji (2019) which states stable electricity supply is needed to promote the

indicates a better level of predictive accuracy. This demonstrates that the independent constructs of the model (REA, REG, REU, and RESE) explain 83% of the

Table 6. R square.

R Square	R-square	R-square adjusted
SME Sustainable Development	0.83	0.83

Source: Author's SmartPLS 4 Output, 2023.

Table 7. Bootstrapping.

Parameters	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (O/STDEV)	P-values
RE Availability -> SME Sustainable Development	0.42	0.42	0.03	12.44	0
RE Generation -> SME Sustainable Development	0.10	0.10	0.03	3.41	0.001
RE System Efficiency -> SME Sustainable Development	0.12	0.12	0.04	3.14	0.002
RE Utilization -> SME Sustainable Development	0.43	0.43	0.03	13.89	0

Source: Author's SmartPLS 4 Output, 2023.

growth of SMEs in Nigeria. Similarly, RE system efficiency was found to have significant effect on the SMEs sustainable development potentials. This goes along with the study of Ibe and Obodoechi (2019) which discovered that improving the implementation of energy efficiency measures by SMEs could lead to momentous benefits. Finally, the finding that RE utilization has significant effect on the sustainable development potential of SMEs in Nigeria is in line with the findings of Babatunde et al. (2019) that RE guarantees clean energy for farming businesses save energy and finances and further development; and Sabo and Lekan (2019) that there is a strong positive relationship between SMEs growth, electricity supply, firm age, firm size, and leverage.

Conclusion and Recommendations

Based on the empirical findings of this study, it was established that RE development positively influences the potential development of SMEs in Nigeria. Specifically, the study established that RE resources availability, generation, system efficiency and effectiveness, and utilization have significant influence on SMEs' sustainable development potential in Nigeria.

It is therefore, recommended that SMEs should be enlightened and supported to identify, access, and equip themselves for the development of RE resources. It is also recommended that SMEs should be encouraged and assisted by major stakeholders to generate RE by simplifying access to RE-generating resources and environment. Moreover, policies and programs should be implemented to make the system viable, adequate, feasible and pretentious for SMEs to effectively and efficiently develop RE. Lastly, SMEs should be made to improve usage and ensure appropriate usage of RE.

CONFLICT OF INTEREST

Authors declare that they have no conflicts of interest.

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