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Original Paper

Assessing the Key Factors Influencing Renewable Energy Generation in Mozambique: A Structural Equation Modelling Analysis

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Abstract

Structural equation modelling analysis was performed to identify various variables that influence the growth of Renewable Energy Production (REG) in Mozambique. The study revealed that the government's policies regarding renewable energy generation in Mozambique are of moderate quality. However, by implementing skillfully crafted policies and plans, there is a possibility for additional progress and growth. The progress of renewable energy initiatives in Mozambique is significantly influenced by the investment climate for such projects. Although the government has established a favourable environment for investors, it primarily caters to foreign investors rather than local and private investors. Environmental considerations significantly influence the growth of renewable energy generation (REG) in Mozambique. This study highlighted the need to consider environmental issues throughout the planning and execution of REG projects. The lack of technical and managerial proficiency in a particular area can be resolved by importing foreign specialists, either on a temporary or permanent basis. Concurrent with the global goal of shifting to clean energy-producing technologies, this study attempts to identify and assess the variables that influence the growth and development of renewable energy businesses in Mozambique. Setting priorities for energy efficiency can uncover several economic prospects, fostering the growth of a market for innovative solutions and facilitating the construction of specialized firms in this field. Consequently, this will entice investment from both domestic business owners and investors from other countries.

Keywords

Renewable Energy Generation Development, Structural Equation Modelling, Renewable Energy, Mozambique

1. Introduction

The UN Sustainable Development Goals (SDGs) are a prime example of sustainable development and are acknowledged as the most successful strategy for reaching development objectives. According to Malley (Malley, 2011), sustainable development enables different economies to expand while using resources without endangering the environment. This paradigm of development stresses the need to combine social and economic goals with environmental factors to guarantee the availability of resources for subsequent generations (Rosen & Farsi, 2022). To forge a new course for prosperity, Mozambique has to prioritize sustainable development in its state policies. To increase the possibility of attaining sustainable development globally. (Zhang & Zhu, 2020) urge nations to continuously strive for it and actively participate in its global realization (Lee & Wang, 2022).

Energy is a crucial component of sustainable development since it provides essential services and is a significant source of revenue for countries (OECD, 2007). Bacon (Bacon, 2004) posited that energy could serve as the primary revenue source for nations that produce it. Akrofi et al. (Akrofi, Okitasari, & Kandpal, 2022) highlighted the energy industry as a key sector that contributes to the attainment of the SDGs. National security, scientific advancement, social development, and economic growth depend heavily on energy resources. The generation of renewable energy is essential for solving energy security and environmental issues (Lee & Wang, 2022; Lee, Xing, & Lee, 2022; Miao, Fang, Sun, & Luo, 2017).

Mozambique, with its vast potential for renewable resources, stands at a critical juncture in its energy development trajectory. With its unexplored mineral and natural resources—coal, hydro, gas, wind, solar energy, agricultural biogas, biomass, bioliquids, and biogas—the nation stands out in southern Africa for its power generating potential (Salite et al., 2021). Currently, Mozambique exports natural gas and imports primarily oil products, which account for 15% of its total imports. Mozambique imports refined oil products to meet its own needs since it lacks significant proven oil reserves and local capacity for either upstream or downstream production (IRENA, 2023). On the bright side, Mozambique possesses significant coal reserves, estimated at 4 billion metric tons (IRENA, 2012). Furthermore, the country has substantial natural gas reserves and production, which are expected to remain important in the future. As of 2011, Mozambique's proven reserves of natural gas were estimated at 127 billion cubic meters (IRENA, 2023). This makes it the 51st-largest proven reserve in the world and the third largest reserve in the Southern African Development Community (SADC) region.

In addition to fossil fuels, the country also possesses tremendous potential for developing renewable energy resources. Prefeasibility studies indicate an estimated potential of approximately 12,000

megawatts (MW) of hydropower energy, (EDM - Electricidade de Mozambique, 2020), solar energy resources throughout the entire country, with an average solar radiation of 5.7 kWh/m2/day, and wind energy resources along the coastline and in the highlands of the interior exceeding an average of 6 m/s (Cuamba, Cipriano, & Turatsinze, 2013). In addition, the nation has substantial geothermal and maritime energy resources (Cuamba, Cipriano, & Turatsinze, 2013; Hammar, Ehnberg, Mavume, Cuamba, & Molander, 2012; G. Martinelli, Dongarr, Jones, & Rodriguez, 2024).

Notwithstanding the early stages of large-scale exploration of renewables, only 41 MW currently contributed to the grid. It is widely recognized that countries with low electrification rates also have lower GDP per capita and consequently less development (Gwénaëlle, Ines, Nigel, & B. Sophie, 2009; Wolde-Rufael, 2006). Despite the commendable efforts of the government of Mozambique to increase electrification in recent years, a significant portion of the population still relies on firewood and other resources to meet their basic needs, which require a certain form of energy (Massuque, Matavel, & Trugilho, 2021). Population growth plays a crucial role in driving energy consumption (Zohuri & McDaniel, 2021, p. 1) However, Mozambique possesses 13 major river basins, providing abundant water resources and significant hydropower potential, making it an ideal candidate for grid extension. Therefore, there is an urgent need to diversify Mozambique's energy mix by incorporating new sources. Nevertheless, relying on national networks for power will continue to be essential in providing energy access solutions. Advancements in sustainable energy technologies, particularly in solar energy, have the potential to significantly expand access to individuals in rural areas that are currently underserved by grid expansion (Vasel & Ting (Eds.), 2019) in the near future.

Despite the country's significant renewable energy capacity, estimated at over 23,000 GW, the current electricity access rate is approximately 40%, with a heavy reliance on traditional biomass accounting for 80% of energy consumption (Cristóvão, Chichango, & Macanguisse, 2021). This reliance contributes to environmental degradation and health issues, underscoring the urgency for Mozambique to harness its renewable energy potential for economic and social advancement.

Although Mozambique's legislative framework for the energy sector has been largely established, the implementation and enforcement of regulations are hindered by financial constraints (Cristóvão, Chichango, & Macanguisse, 2021). For instance, Taiwan region has turned to innovative financing methods such as crowdfunding to overcome such hurdles (Chiu, Lin, & Liang, 2021), and the global market for environmental project financing, including instruments such as green bonds, is evolving to support renewable energy development [23]. Renewable energy projects have been essential in advancing sustainable development through international processes such as the Clean Development Mechanism (CDM) (Lim, Lam, & Shamsuddin, 2013).

Low rates of electricity availability and a strong reliance on biomass characterize Mozambique's renewable energy sector, which is severely constrained financially. A comparative analysis of other regions indicated that creative funding and global collaboration could overcome these obstacles and advance Mozambique's renewable energy economy. The need to provide energy security and reduce

environmental effects is what ignites interest in renewable energy sources (Morina, Balomenou, & U. Ergün, 2021; Voyko, 2020). The energy industry of Mozambique is vital to the country's economy since it supplies necessary inputs for all economic activities. The energy supply and demand have been dynamic in the industry during the last ten years, especially in conventional power generation, transmission, and distribution. Prefeasibility studies show that a number of elements, including financial availability, technology developments, government policies and laws, and the availability of natural resources, affect the creation of renewable energy enterprises (Cuamba, Cipriano, & Turatsinze, 2013). Regulations and policies of the government foster a good climate in which renewable energy enterprises can prosper. The capacity of these enterprises to spend on equipment and infrastructure is determined by their access to finance. Innovations in solar and wind energy technologies are examples of how technology is advancing to support the increase in renewable energy production. In Mozambique, the viability and promise of renewable energy projects are mostly determined by the availability of natural resources such as sunlight and wind. Mozambique's potential in this area and alignment with larger economic and environmental goals depend on an understanding of the elements impacting the growth of renewable energy generating firms.

Both strong economic arguments and environmental advantages are driving the switch to renewable energy. When government programs and policies are in place, renewable energy can improve competitiveness and provide financial gains (Voyko, 2020). The combination of renewable energy with financial technology (fintech) implies that financial advances can support the long-term growth of these enterprises (Jiang, 2023). However, the efficiency of renewable energy investment and the role of shareholder control and green financial development are also significant considerations (Wang & Zhao, 2022). The development of renewable energy generation enterprises in Mozambique is likely influenced by a complex interplay of environmental policies, economic incentives, technological innovation, and financial mechanisms. The factors impacting this development are multifaceted, encompassing government support, financial development, technological efficiency, and market dynamics (Chen & Song, 2023; Ren & Li, 2023)

As Mozambique seeks to expand its renewable energy sector, it is imperative to examine these factors in detail to inform policy and practice, thereby contributing to the sustainable growth of renewable energy enterprises within the country. Thus, this study aimed to investigate the key drivers and barriers that impact the smooth development of renewable energy generation enterprises on land. One of the key drivers that impacts the advancement of green energy generation enterprises in Mozambique is the government's commitment to promoting clean energy. The government has put laws and incentives in place to promote funding for renewable energy initiatives, creating a favourable environment for the growth of the sector. Additionally, the growing need for electricity in Mozambique, in addition to the requirement to lower reliance on fossil fuels, has created a market opportunity for renewable energy generation enterprises. By addressing the barriers and leveraging these drivers, Mozambique can unlock its vast potential in the sector and contribute to a sustainable future.

2. Literature Review and Research Hypotheses

Research hypotheses were developed to comprehensively analyse the key factors influencing the growth of renewable energy generation in Mozambique. These hypotheses were based on the multifaceted content analysis (MFCA) method used by Fatima et al. (2021) (Fatima, Li, Ahmad, Jabeen, & Li, 2021) in their study on the factors influencing renewable energy generation in Pakistan.

2.1 Study Hypotheses Selection and Classification

(1) *Selection and Classification of hypotheses from the literature*: First stage

Using databases such as Scopus, Science Direct, Wiley, SpringerLink, and Web of Science, a thorough literature search was performed with an emphasis on terms such as "renewable energy generation", "influencing factors", and "crucial factors". Finding these aspects was made possible in large part by the MFCA approach (Zhao & Chen, 2018).

(2) *Selection and classification of hypotheses in the context of Mozambique*:

To examine in detail the factors influencing the development of REG, both the academic literature and policy documents were studied in depth. The MFCA revealed a variety of factors that could influence the development of renewable energy. However, not all factors were applicable and feasible in the case of Mozambique. Therefore, in this study, the influencing factors of REG were modified by MFCA in the context of Mozambique. First, socioeconomic factors such as GDP, CO_2 emissions, and oil prices influence the uptake of renewable energy in both developed and emerging countries (Elmassah, 2021). Similarly, the role of green finance and energy efficiency in promoting economic growth and reducing carbon emissions is highlighted, which could be relevant to Mozambique's context (Tiawon & Miar, 2023). Again, from the literature reviewed, the influence of government policy, technological advancement and the need for strategic installations and investments are emphasized as crucial for the development of renewable energy, especially in the African context. The influence of government expenditures on research and development and renewable energy deployment on green economic growth is another factor to consider (Mohsin, Taghizadeh-Hesary, Iqbal, & Saydaliev, 2022). Moreover, a review of India's renewable energy scenario provides insights into the barriers and policies that could be applied to Mozambique (Elavarasan et al., 2020). Based on the context of Mozambique, six key factors were identified that influence the development of REG, including the investment environment, government energy policy, environmental issues, public acceptance, government and policy, and education and training. The hypotheses based on the key factors influencing REG development are shown in Figure 1.

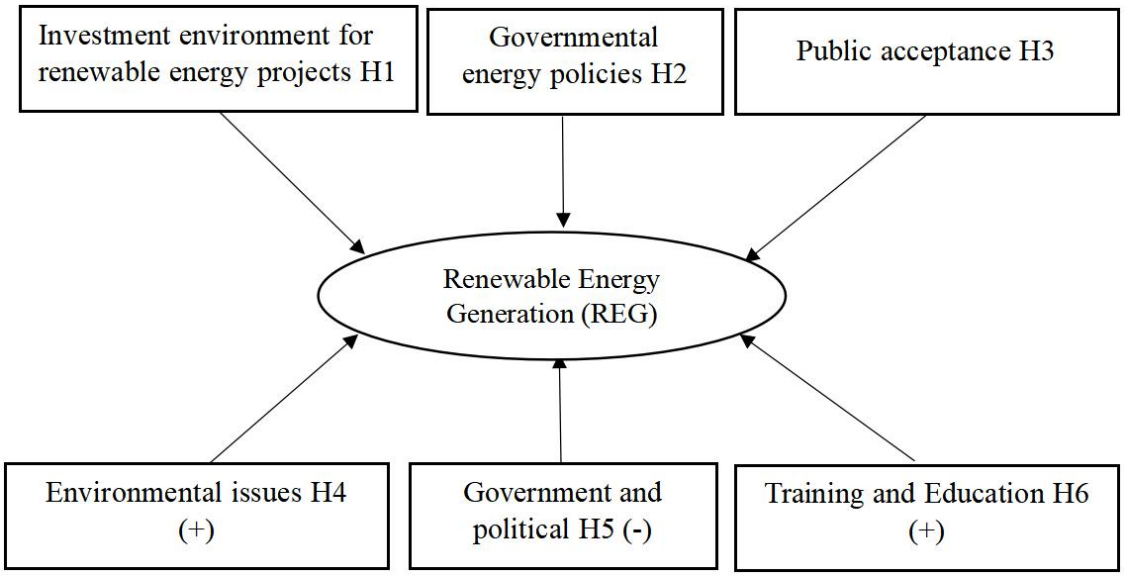

Figure 1. Factors that Influence REG Development

Source: Authors' elaboration based on the literature review.

2.2 Investment Environment for Renewable Energy Projects

The investment climate is essential to REG growth and is influenced by interest rate swings, lending availability, and investment returns. A good investment environment, including foreign direct investment, subsidies, tax breaks, and incentives, is required for large financial outlays (Inglesi-Lotz & Ajmi, 2021).

Bento et al. (2020) evaluated the effect of auctions in promoting the expansion of renewable energy capacity and identified the motivation for tendering in 20 developed countries (Bento, Borello, & Gianfrate, 2020). Sindhu et al. (2016) emphasized the political and economic concerns that are crucial for the promotion of renewable energy in light of the Indian economy (Sindhu, Nehra, & Luthra, 2016). The investment climate, which is influenced by investment returns, loan availability, and loan interest rate fluctuations, is crucial for the expansion of sustainable energy. Large-scale financial support is necessary to progress the renewable power industry because it is an investment-intensive sector. Therefore, one major factor influencing the sector's ideal growth, particularly in its early stages, is the availability of suitable loans. In their most recent analysis, Inglesi-Lotz and Ajmi (2021) underscored the significance of FDI in renewable energy projects and its associated impact on energy supply and pricing. They also highlighted that investors prioritize their possible gains (Inglesi-Lotz & Ajmi, 2021) and that the greatest risk facing REG projects is the fluctuation of loan interest rates (Ravetti, Theoduloz, & Valacchi, 2020). The government should provide more financial support in the form of subsidies, tax breaks, incentives, and other favourable policies to promote the development of power technologies in this country (Gambardella, Pahle, & Schill, 2020). Based on these arguments, the following hypothesis is derived.

H1: Mozambique's investment climate is expected to affect the growth and creation of renewable energy enterprises.

2.3 Governmental Energy Policies

The growth of REG depends critically on efficient regulatory and policy frameworks. Regulations governing grid integration, emissions, tax breaks, and feed-in tariffs all affect the use and investment of renewable energy systems. A major factor in Pakistan's development of Renewable Energy Groduction (REG) is the legislative and strategic framework (Khattak, Ul Hassnain, Shah, & Mutlib, 2006). Reduced government monopolies in the energy industry (Nicolli & Vona, 2019) and cooperation with international organizations can promote REG development (Maqbool & Sudong, 2018). In the case of Ghana, Obeng-Darko's report indicated that the renewable energy sector is beset by a number of governmental, legal, and regulatory challenges that make it extremely unlikely to achieve its target of 9.5% renewable electricity (Kampman, Sina, Lucha, Cesbron, Pato, & O. Flörcken, 2015; Obeng-Darko, 2019).

H2: In Mozambique, the creation and growth of renewable energy enterprises are expected to be influenced by government energy policy.

2.4 Environmental Issues

The environmental effects and greenhouse gas emissions have increased the demand for renewable energy sources. Considerable issues that renewable energy tackles are air pollution, climate change, and environmental sustainability. Generating energy through renewable means would help reduce resource depletion and ensure energy sustainability. The global importance of renewable energy generation is recognized, as it reduces hazardous emissions and is considered significant for countries such as China and Sub-Saharan Africa. By advancing renewable energy sources, the reduction of carbon emissions can be minimized.

H3: The growth and creation of renewable energy enterprises in Mozambique are significantly impacted by environmental factors.

2.5 Public Acceptance

Public awareness of environmental issues has led to a shift in attitudes towards Renewable Energy Generation (REG). Stakeholders now recognize both the benefits and drawbacks of REG, with public acceptance being a key barrier to its expansion (Fashina, Mundu, Akiyode, Abdullah, Sanni, & Ounyesiga, 2019). Government incentive programs, such as funding for research and development, tax breaks, subsidies, and fair tariffs, are essential for promoting REG adoption (Roth, Boix, Gerbaud, Montastruc, & Etur, 2019). In countries such as Pakistan, where financial resources are limited, risk assessment and investor acceptability play crucial roles in determining the feasibility of REG projects (Fashina, Mundu, Akiyode, Abdullah, Sanni, & Ounyesiga, 2019). Overall, social approval, insurance coverage, and investor willingness are key factors influencing the growth of REG (Amer & Daim, 2011).

H4: Public approval significantly influences the growth and creation of renewable energy businesses in

Mozambique.

2.6 Government and Political

Energy policy is the body of laws controlling the interactions between society, business, and the government regarding energy (Fontaine, 2011). The development of REG depends critically on efficient energy governance (Inglesi-Lotz & Ajmi, 2021). Reaching the goals for renewable energy is hampered by regulatory problems and unclear strategic orientations (Obeng-Darko, 2019). The adoption of renewable energy and energy governance has been found to be positively correlated (Fernando et al., 2018).

H5: Government and politics are expected to negatively impact renewable energy generation development in Mozambique.

2.7 Training and Education

Organisational change in the renewable energy industry depends critically on human resources (Odulaja, Nnabugwu, Abdul, Udeh, & Daraojimba, 2023). A qualified workforce ready to use and maintain renewable energy technologies requires education and training. Programs for development, decision-making, and strategic planning improve REG capacity (SHAULSKA & TARASENKO, 2024). The Ministry of Science in Mozambique oversees universities and research facilities, with a focus on renewable energy at Universidade Eduardo Mondlane and Mozambique Pedagogical University (I. Cancela de Abre et al., 2024). Challenges include a lack of knowledge, certification standards, skilled resources, and funding, hindering renewable energy development. The Dutch Government supports technology and knowledge transfer in Mozambique's energy sectors to improve renewable energy capacity through education and training (FUNAE, 2024).

H6: In Mozambique, the growth and creation of renewable energy enterprises are significantly influenced by training and education.

These theories provide the framework for comprehending the complex elements influencing the production of renewable energy in Mozambique and suggest a strategy for promoting its growth by means of focused policies and calculated actions.

3. Materials and Methods

3.1 Study Location

This study was conducted in the cities of Maputo Province, Matola and Maputo. These areas were chosen for their significant representation in the political, academic, administrative, and economic spheres—even in regard to issues unrelated to renewable energy. The centralized system predominant in Mozambique makes Maputo the centre of education institutions, investment platforms and companies. The factors mentioned above and the hypotheses formulated above make the study location a proper place with significant representative value that is fit for our study objectives. Therefore, questionnaires were simultaneously administered in the professional, academic and social spheres.

3.2 Study Questionnaire and Participants

The questionnaire was designed based on both current and earlier relevant studies in line with the objectives of this study. The respondents were from the following groups: researchers, students, energy enterprise members of the general public, and managers of energy-related businesses and institutions. A combination of 150 paper-based surveys and 1 electronic survey were available, and the final result was 107 valid samples and 43 invalid samples. Thus, the response rate was 71%, which is well above the threshold level of 20%. For survey questionnaire data, a response rate of 20% or above is considered suitable (Luthra & Minoo, 2016). A sample of the questionnaire survey is provided in the Appendix. The paper-based questionnaire was the main and most effective data gathering method due to respondents' preference for the electronic version of the questionnaire.

3.3 Demographics

An overview of the data based on demographic characteristics is shown in Table 1. Male respondents made up the majority (56.1%); however, female respondents made up a sizable share (43.9%). Most respondents (44.9%) were between the ages of 26 and 35, with 31.8% between the ages of 18 and 25. Respondents between the ages of 36 and 45 made up the third-largest age group (14.0%); those between the ages of 46 and above 55 made up the smallest proportion (8.4% and 0.9%, respectively). Among the responders, the general public made up the largest group (50.5%), followed by researchers/students (34.6%). Energy sector workers accounted for the third-largest category (14.0%), although only one manager responded to the poll.

Although only one manager responded, workers in the energy industry accounted for the third-largest group (14.0%).

The respondents had degrees ranging from technical to master's degrees. With respect to working in many different industries that support the energy sector, the general public accounted for the most (50.5%).

The energy sector employees (14.0%) ranked third, followed by the researchers/students (34.6%). Twelve percent of the respondents had between two and five years of experience, while three percent had between eleven and fifteen years. Of those surveyed, only 0.9% had more than 15 years

Table 1. Demographic Features

Gender	Frequency	Percentage
Male	60	56.1
Female	47	43.9
Age		
18-25yrs	34	31.8
26-35yrs	48	44.9

36-45yrs	15	14.0
46- 55yrs	9	8.4
Above 55yrs	1	0.9
Status		
Energy Enterprises Managers	1	0.9
Energy Sector Employees	15	14.0
Researchers/Students	37	34.6
General Public	54	50.5
Years of Work Experience		
Less than 1 year	3	2.8
2-5 years	13	12.1
6 - 10 years	3	2.8
11-15 years	4	3.7
More than 15 years	1	0.9

3.4 Statistical Analyses and Results

The influence factors identified through an MFCA were subjected to empirical analysis employing the PLS-SEM approach. The scales of measurement are based on five agreement levels on the Likert scale, which are given as “SD= Strongly Disagree”, “D= Disagree”, “U= Uncertain”, “D= Disagree”, “A= Agree”, and “SA= Strongly Agree”. The SPSS and SmartPLS software packages were utilized for the assessment of the measurement model as well as the structural model.

3.5 Measurement Model Results

Confirmatory factor analysis CFA was used to assess the reliability and credibility of the developed measures. The factor loadings were initially evaluated (Table 2), and a loading value of 0.7 or above was deemed appropriate, indicating a more than 50% explained variance. On the other hand, factor removal was required if the loading value was less than 0.7.

Reliability pertains to the consistency of the construct (Bortoleto, Kurisu, & Hanaki, 2012). To assess reliability, composite reliability (rho c) and Cronbach’s alpha (C. alpha) were used. A magnitude between 0.7 and 0.95 is deemed satisfactory. However, due to its tendency to undervalue reliability for small samples, C. alpha is not the preferred measure. Instead, rho c is recommended as an empirical counterpart (Hair, M. Sarstedt, Hopkins, & Kuppelwieser, 2014). The rosy Prior research also took into account a coefficient that falls between the rho c and C. alpha values. (Tan, Ooi, & Goh, 2017). According to Table 3, convergent validity describes how well a measure agrees with other loadings of indicators and other measures of the construct. The index that validates this standard is the Average Variance Extracted (AVE) (Sarstedt, Ringle, Smith, Reams, & Hair, 2014). The convergent validity and reliability of the measuring model were statistically supported by the AVE values surpassing the 0.5 criterion. The average variance retrieved must equal or exceed 0.50, and the composite reliability must

equal or exceed 0.70 for a model to be deemed statistically significant, according to SEM standards. This results in a high Cronbach's alpha value (0.774-0.856), which gauges the measurement tool's internal consistency.

Additionally, discriminant validity needs to be substantially validated. The values on the hyperplane are the square-root of the Average Variance Extracted (AVE) of the variables, and these numbers should be larger than the intercorrelation between the variables, according to the discriminant validity using the Fornell Larcker criteria. To do this, Lee and Hu (2018) proposed using the square root of the AVE to determine the discriminant validity in cases where it exceeds the construct's correlation measure (Lee & Hu, 2018). Table 2 illustrates that every correlation that was examined among the LVs was less than the square roots of the AVE, indicating discriminant validity (Hair, Sarstedt, Hopkins, & Kuppelwieser, 2014). This means that the discriminant validity of our model is satisfactory.

Table 2. Development of the Model's Validity and Reliability

	Cronbach's alpha	Composite reliability (rho_c)	Average variance extracted (AVE)
Acceptability & Willingness	0.856	0.903	0.699
Economic Factors	0.825	0.884	0.656
Environmental Factors	0.83	0.887	0.664
Government & Political	0.78	0.864	0.68
Legal Factors	0.774	0.899	0.816
Training & Education	0.82	0.895	0.741
Renewable Energy Generation	0.782	0.873	0.696

Table 3. Discriminant Validity Using the Fornell Larcker Criteria

	Acceptability & Willingness	Economic Factors	Environmental Factors	Government & Political	Legal Factors	Renewable Energy Generation	Training & Education
Acceptability & Willingness	0.836						
Economic Factors	0.613	0.81					
Environmental Factors	0.672	0.723	0.815				
Government	0.521	0.644	0.599	0.825			

& Political							
Legal Factors	0.467	0.613	0.645	0.569	0.903		
Renewable Energy Generation	0.594	0.699	0.722	0.586	0.694	0.834	
Training & Education	0.421	0.574	0.737	0.505	0.669	0.624	0.861

3.6 Structural Model Testing

Analysing endogenously determined constructs is a crucial step that involves calculating the R2 value, which evaluates the structural model's predictive validity. Within the behavioural sciences, an R2 value of more than 0.25 is regarded as adequate, and an average value of approximately 0.13 is considered suitable. Generally, values less than 0.02 are considered weak (Fatima, Li, Ahmad, Jabeen, & Li, 2021; Cohen, 2013). The next stage is to assess the path coefficient magnitudes and the significance level, which shows how strongly the constructs are related to one another. An important effect inside the model is considered to be shown by values of the estimate greater than 0.1. Evaluating the path coefficient values and the significance level—which indicate how closely the constructs are related to one another—comes next. An important effect inside the model is considered to be shown by estimate values larger than 0.1 (Hubert & Branden, 2003). The importance of probability values less than 0.05 is also established. Furthermore, the t-ratio is computed, which is obtained from Student's t-distribution.

The route coefficients are shown to be substantially different from zero when the t-ratio is 1.96 or higher, and at a significance level of 5%, the same is demonstrated by a probability value of less than 0.05 (Ketchen, 2018). Table 3 shows that both the influence of legal and economic factors on the generation of renewable energy have high T values greater than 1.96, which satisfies the requirement of a T value >1.96 at the 95% interval because our data are symmetrical. High consistency and little volatility are indicated by the incredibly low standard deviation of each variable. Thus, not every hypothesis is acceptable according to these criteria.

The only factors that significantly affect the Generation of Renewable Energy (REG) are economic and legal factors. The model in this study suggests a clear positive association between the independent variables and the dependent variable. This is because economic and legal factors have relatively high coefficients of 0.218 and 0.288, respectively, at $p < 0.05$. The other independent variables, government and politics, training and education, acceptability and willingness, and environmental factors, do not contribute significantly to renewable energy generation. The p values were all greater than 0.05, and their coefficients seemed low; hence, the requirement that the p value be less than 0.05 was not met.

The R-square value of the dependent variable (0.655) is high, indicating that the model is sound. The degree of variation in the dependent variable that the dependent variable has been able to explain is

indicated by the R-square value. All of the indicators in Table 4, at $p<0.05$, have significant correlations with the independent variables (latent construct). This indicates that the indicators, which have high coefficient values ranging from 0.738 to 0.904, significantly reflect the independent variables (latent construct).

Table 4. Factor Loading

Variables	Factors	code	p value	Coefficient	Decision
Government and Political	Type of governance	Gov & Polit_1	0.000	0.738	Supported
	Government energy policies	Gov & Polit_2	0.000	0.826	Supported
	Tariffs and taxation	Gov & Polit_3	0.000	0.902	Supported
Economic	Cost of energy generation	Econ_1	0.000	0.790	Supported
	Economic returns on renewable	Econ_2	0.000	0.833	Supported
	Investment environments	Econ_3	0.000	0.804	Supported
	National financial scheme for RES	Econ_4	0.000	0.812	Supported
Legal	Timely update of legislation	Legal_1	0.000	0.904	Supported
	Energy licence procedure	Legal_2	0.000	0.902	Supported
Training and Education	Locally available technical expertise	Train…du_1	0.000	0.863	Supported
	Available technical training mediums	Train…du_2	0.000	0.951	Supported
	Human resource evaluation	Train…du_3	0.000	0.757	Supported
Public Acceptability and Willingness	Willingness to purchase renewable energy	Acc & Wil_1	0.000	0.871	Supported
	Incentive-based policies to public	Acc & Wil_2	0.000	0.815	Supported

	Energy demand by public	Acc & Wil_3	0.000	0.853	Supported
	Energy adaptation	Acc & Wil_4	0.000	0.803	Supported
Environmental Effects	Geographical location and weather	Env_1	0.000	0.871	Supported
	Environmental Target	Env_2	0.000	0.815	Supported
	Emissions and other pollutants	Env_3	0.000	0.853	Supported
	Reliance on environment risk	Env_4	0.000	0.803	Supported
Renewable Energy Generation	Power production approach	Prod_1	0.000	0.770	Supported
	Endowed available resources	Prod_2	0.000	0.861	Supported
	Proper sizing of projects	Prod_3	0.000	0.868	Supported

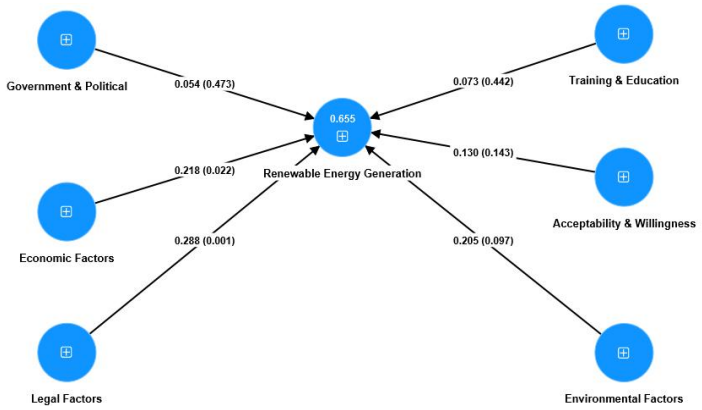

Figure 2. Path Coefficients and p Values of the Structural Model

Table 5. Structural Equation Model Results

Crucial Influences factors (CIF's)	Coefficient	Sample mean	Standard deviation	T values	P values	Decision
Acceptability & Willingness	0.13	0.139	0.088	1.465	0.143	Not Supported
Economic Factors	0.218	0.217	0.095	2.294*	0.022	Supported

Environmental Factors	0.205	0.197	0.123	1.662	0.097	Not Supported
Government & Political	0.054	0.058	0.076	0.717	0.473	Not Supported
Legal Factors	0.288	0.29	0.088	3.294*	0.001	Supported
Training & Education	0.073	0.069	0.095	0.769	0.442	Not Supported

The t-ratio and probability values indicated that not every hypothesis was pertinent to the creation of the REG. Only three route coefficients were found to be significantly different from zero in the data, suggesting that they are relevant to the formation of REG. Table 5 indicates that only three parameters were considered meaningful based on the route coefficient estimates. As shown in Tab. 4, the predicted route coefficient magnitudes from the structural model were used to determine the relative importance of the crucial impact variables in REG formation. Legal (government energy policy), economic, and environmental variables were shown to be the top three CIFs of REG development in Mozambique, with path coefficients of 0.288, 0.218, and 0.205, respectively. In contrast, research by (Fatima, Li, Ahmad, Jabeen, & Li, 2021) revealed a deficiency in effective governance.

Therefore, the main determinants of Renewable Energy Production (REG) in Mozambique—the environment, economy, and government energy policies—are viewed as obstacles to the development of REG in the nation. It is crucial to remember that these results can differ in other countries, as OECD countries have not found that governmental energy regulations hinder REG advancement (Nicolli & Vona, 2019). On the other hand, *Fatima* et al*. (2021) and Yan* et al*. (2019)* found that, in contrast to Mozambique, public approval is a major factor driving the growth of REG in Pakistan. In Mozambique, acceptance and willingness are seen as important obstacles to REG progress.

It is obvious that many countries have different factors affecting the production of renewable energy, which highlights the need to consider the unique conditions of each nation. Finally, the empirical results from SEM and survey-based research have shown that the obstacles encountered are significant factors in the expansion of the Renewable Energy Generation (REG) of Mozambique. The importance of this study's findings is based on their consideration of the impacts of barriers such as government energy policy, the environment, and economics. Mozambique's energy sector has not experienced significant growth due to the nation's unstable and economically challenging history, resulting in a lack of electricity availability for the majority of its population. However, this also shows how effectively government energy policies and sound governance could act as stimulants for REG expansion in Mozambique.

Similar findings have been observed in Pakistan, where REG development has faced challenges

(Maqbool & Sudong, 2018), as well as in sub-Saharan African countries such as Ghana (Adams & Acheampong, 2019; FUNAE, 2024). These countries are also facing similar obstacles in their efforts to advance REG.

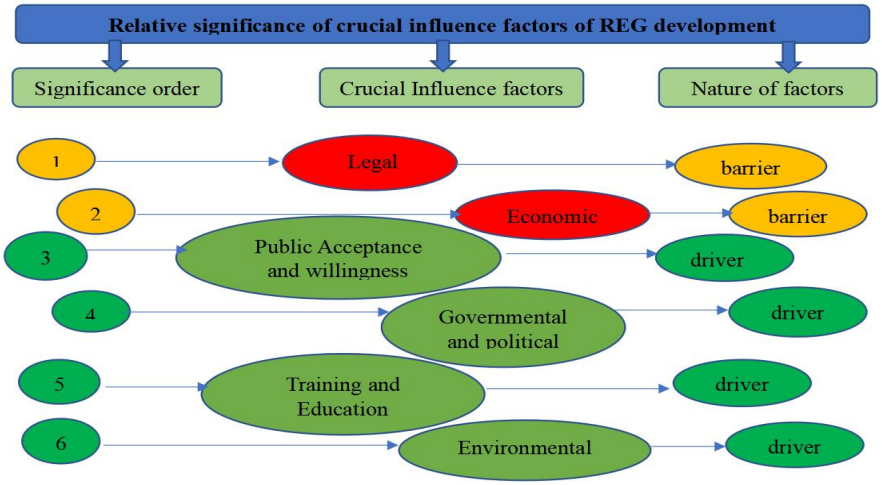

Figure 4. Relative Importance of Key Influencing Elements of REG Development as Determined by Structural Models

Source: elaboration by the authors based on SEM results.

4. Discussion and Recommendations

4.1 Governmental Energy Policies

The study's findings imply that poorly handled government energy policy could be a significant barrier to the creation of REGs. To foster the production of renewable energy, a strategic and legislative framework is necessary (Khattak, Ul Hassnain, Shah, & Mutlib, 2006). In Mozambique, the Energy Regulatory Authority (ARENE) has been putting policies into place to enhance the legal environment surrounding renewable energy initiatives. The "Energy for All" programme was launched by the government, and 20% of the country's energy comes from renewable sources. Encouraging private investment in off-grid and renewable energy initiatives while guaranteeing supervision, control, examination, and fines is the goal. Additionally, the use of renewable energy sources can help with energy issues by lowering the consumption of fossil fuels, which have a large negative impact on the atmosphere (Gyamfi, Ozturk, Bein, & Bekun, 2021). Policies such as feed-in-tariff rules and renewable portfolio criteria can significantly impact renewable energy generation, as described by Fatima et al. (Fatima, Li, Ahmad, Jabeen, & Li, 2021).

4.2 Investment Climate and Financial Incentives for Renewable Energy Development

The investment environment greatly affects the progress of REG projects. Financing constraints, unstable banking systems, and startup challenges deter foreign investment (Kinda, 2010). Mozambique's Renewable Energy Auction Program (PROLER) aims to launch renewable energy transparently and competitively, attracting international investors such as the Nordic Green Bank and

GET.invest. Foreign direct investment is crucial for renewable energy projects, as highlighted in various studies (Sindhu, Nehra, & Luthra, 2016). However, the investment climate is more favourable to foreign investors than to local investors, partly due to the monopolization of the energy sector by state entities such as FUNAE and EDM (Maqbool & Sudong, 2018). To foster REG, Mozambique needs diverse financing options, including partnerships with international organizations and development banks, as well as government subsidies or tax incentives to attract private investors.

4.3 Socioeconomic and Environmental Drivers and Barriers

Mozambique's socioeconomic structure, particularly the disparity between urban and rural areas, impacts renewable energy adoption. The reliance of rural areas on agriculture and the high cost of renewable technologies have forced them to depend on harmful fossil fuels and biomass. China's experience with rural electrification highlights the importance of public participation and government support (Luo & Guo, 2013). Investor motivation in REG projects is linked to economic profits, but high costs hinder local investor participation (Bhutto, Bazmi, Zahedi, & Klemeš, 2014). On the one hand, the connection between economic profits and investor motivation in renewable energy generation (REG) projects is indisputable; this fact is also valid for enterprises in Mozambique. Estimating and evaluating renewable energy resources are crucial for launching these projects. Enhanced research, which provides precise estimation and evaluation of renewable energy methods, bolsters investor confidence in the financial viability and risk reduction of these projects (Fashina, Mundu, Akiyode, Abdullah, Sanni, & Ounyesiga, 2019).

4.4 Environmental Factors

This study also showed that Mozambique's development of Renewable Energy Generation (REG) is significantly influenced by environmental conditions. This conclusion aligns with similar research conducted in Pakistan by (Fatima, Li, Ahmad, Jabeen, & Li, 2021) and (Zhao & Chen, 2018) in China (2018) and in several sub-Saharan African nations by (Fashina, Mundu, Akiyode, Abdullah, Sanni, & Ounyesiga, 2019). Rehman et al. (2019) evaluated the ways in which Pakistan and other developing countries could mitigate the adverse impacts of climate change by encouraging the production of renewable energy. This report highlights the significance of national-level actions to reduce greenhouse gas emissions to support global efforts to address climate change (Dogan & Inglesi-Lotz, 2020). Mozambique faces environmental degradation due to power production, highlighting the need for sustainable development in renewable energy projects (Das et al., 2017). Mozambique can utilize its environmental advantages to develop its REG sector and achieve a sustainable energy future by learning from countries such as Pakistan, China, and Sub-Saharan Africa.

4.5 Government and Political Factors

Good governance is crucial for REG development in Mozambique. Effective power sector governance and strategic planning can enhance renewable energy production. Sen and Ganguly's (2017) study underscored the significance of effective governance in fostering renewable power production, highlighting key factors such as long-term strategies, legal structures, financial incentives, and global

cooperation (Sindhu, Nehra, & Luthra, 2016; Sen & Ganguly, 2017; Yaqoot, Diwan, & Kandpal, 2016). Regulatory issues and an unpredictable legal environment pose significant barriers. Effective governance can reduce investment risks, attract investors and ensure universal access to clean energy, aligning with the seventh Sustainable Development Goal (SDG) (Fatima, Li, Ahmad, Jabeen, & Li, 2021). Ensuring that every household has access to sustainable energy is a national responsibility. Mozambique faces regulatory hurdles in renewable energy development, creating uncertainty and risk perception among investors and hindering its green society ambitions in Africa (Obeng-Darko, 2019).

4.6 Training and Education

Training and education are vital for renewable energy production in Mozambique. The lack of technical expertise for installing, operating, and maintaining renewable energy systems is a major obstacle. Strengthening ties between the academic and private sectors, expanding training programs, and addressing certification requirements are crucial steps. Retaining skilled workers is another challenge, as many trained technicians seek higher-paying jobs abroad or in other energy sectors. Education and training should be decentralized to reach areas where projects are located. Promoting entrepreneurship and gender equality through training programs can also be beneficial. Importing updated qualifications and know-how to build local capacity is necessary, and easing immigration requirements for temporary work permits could help. Funding educational and training facilities are crucial, with public skill development prioritized and funded by the state budget.

5. Strengths, Limitations, and Future Research

This study employed partial least squares-based Structural Equation Modelling (SEM) to analyse the factors influencing REG development in Mozambique. SEM offers advantages in understanding the significance of financial and nonfinancial metrics for renewable energy projects. Both types of metrics significantly impact project success, complementing each other rather than acting as substitutes. However, the study has limitations, such as not covering all societal areas and ignoring factors related to perception and technology adoption. Future research should explore these factors and conduct systematic analyses to understand their behaviors. Follow-up studies on implemented projects can evaluate their effectiveness and sustainability, providing insights for policymakers.

6. Conclusion

Using structural equation modelling, the study determined the main variables impacting REG development in Mozambique as follows:

- Government policies towards renewable energy generation and development in Mozambique are viewed as average; however, the government's expertly handled policies and strategies may possess the potential to further them.
- REG initiatives are greatly impacted by the investment climate, which necessitates the support of both domestic and foreign investors.

- Environmental considerations and the ability to recruit investments and guarantee sustainable energy availability depend heavily on effective governance.
- Enhancing education and training is necessary to close the technical expertise gap. The long-term success of education and training facilities depends on funding and strategic support, as these factors are crucial for the development of REG in Mozambique.

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Conflict of interest declaration

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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