

## Analysis the Impact of Renewable Energy on Work Needs Mediating the Welfare of Fishermen in Aceh Besar

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### ABSTRACT

Fishermen's welfare is a critical issue in economic and social development, especially in coastal areas like Aceh Besar. The implementation of renewable energy not only impacts cost reduction but also addresses fishermen's work needs. Through renewable energy technology adoption, fishermen can enhance productivity with more efficient fishing gear and longer operational durations without returning to land for refueling. This study employs Partial Least Squares (PLS) structural equation modeling to investigate the intricate relationships among Economic Growth (EG), Fishermen's Work Needs (FWN), Use of Renewable Energy (USE), and Welfare of Society (WS). The analysis reveals that Economic Growth significantly enhances Fishermen's Work Needs, indicating that economic improvements drive increased demands and requirements in the fishing sector. Although Economic Growth positively influences Welfare of Society, this relationship lacks statistical significance, suggesting a moderate effect. Conversely, the Use of Renewable Energy positively impacts both Fishermen's Work Needs, and significantly enhances Welfare of Society, the minimal influence of Fishermen's Work Needs on Welfare of Society. underscores the limited direct effect of sector-specific needs on broader societal outcomes. These findings provide critical insights for policymakers and stakeholders in developing sustainable development strategies that balance economic growth, renewable energy adoption, and societal welfare.

## **INTRODUCTION**

Fishermen's welfare is a critical issue in economic and social development, especially in coastal areas like Aceh Besar. Fishermen in this region heavily rely on marine resources for their livelihoods but often face significant challenges such as high operational costs, climate change impacts, and vulnerability to fluctuating fuel prices. Therefore, the use of renewable energy emerges as a potential solution to address some of these challenges and enhance fishermen's welfare. In Aceh Besar, fishermen encounter various challenges affecting their welfare, including the predominant use of fossil fuels for their vessel operations, which are subject to fluctuating and often high costs. High dependence on fossil fuels makes fishermen vulnerable to price increases and supply shortages. Conventional and less efficient fishing gear often increases operational costs and reduces catch yields. Renewable energies such as solar and wind have significant potential for application in the fisheries sector in Aceh Besar. Some potential benefits include Reducing fishermen's dependence on fossil fuels, thereby lowering operational costs. Assisting in reducing carbon emissions and negative environmental impacts on marine ecosystems. the efficiency of renewable energy technologies can enhance fishermen's productivity and catch yields.

The implementation of renewable energy not only impacts cost reduction but also addresses fishermen's work needs. Through renewable energy technology adoption, fishermen can enhance productivity with more efficient fishing gear and longer operational durations without returning to land for refueling. Renewable energy enables fishermen to manage their work schedules more flexibly, maximizing fishing time. With lower operational costs and higher efficiency, fishermen can sustain their livelihoods over the long term. Fishermen's welfare can be assessed through various indicators. Increased productivity and efficiency can directly lead to higher incomes for fishermen. Access to cheaper and environmentally friendly energy can improve the quality of life for fishermen and their families, such as through better access to education and healthcare. With reduced costs and increased catch yields, the sustainability of fishermen's enterprises can be more assured, providing greater economic security.

The research impact of renewable energy on fishermen's work needs and welfare in Aceh Besar is crucial to provide empirical evidence of the benefits and impacts of renewable energy in the fisheries sector. It provides relevant information for policy-making by governments and other stakeholders, encouraging more fishermen to adopt renewable energy through awareness and information dissemination about its benefits. With this background, this study aims to comprehensively evaluate the impact of renewable energy on fishermen's work needs and welfare in Aceh Besar, and to provide recommendations for enhancing their welfare sustainably.

The integration of renewable energy into Aceh Besar's fishing communities promotes sustainable development practices. Localized energy solutions, such as community-owned solar arrays or micro-grids, empower communities to manage their energy resources responsibly. This participatory

approach fosters environmental stewardship and encourages the adoption of sustainable practices in fishing operations. By aligning economic development with environmental conservation goals, renewable energy initiatives support the balanced growth of coastal regions and ensure the resilience of marine ecosystems (Heydari et al., 2023). While renewable energy initiatives offer substantial environmental benefits, challenges such as land use impacts from large-scale solar or wind installations, and potential disturbances to marine habitats from offshore energy projects, require careful planning and mitigation strategies. Effective environmental monitoring and impact assessments are essential to minimize negative effects and maximize the sustainability of renewable energy development in Aceh Besar.

### ***Research Objectives***

1. Assess the economic impact of using renewable energy on the income and expenditures of fishermen.
2. Analyze changes in fishermen's quality of life related to the use of renewable energy.
3. Evaluate the environmental impact of implementing renewable energy in fishing communities.
4. Develop recommendations for optimizing the use of renewable energy to enhance fishermen's welfare.

This research aims to identify and analyze the influence of using renewable energy on the welfare of fishermen in Aceh Besar, focusing on how renewable energy mediates fishermen's work needs. The following are the problem formulations to be addressed in this study:

1. What are the socio-economic conditions of fishermen in Aceh Besar before and after the implementation of renewable energy?
2. What types of renewable energy are used by fishermen in Aceh Besar and how are they implemented in fishing activities?
3. How does the use of renewable energy affect the work needs of fishermen in Aceh Besar?
4. To what extent does renewable energy contribute to improving the welfare of fishermen in Aceh Besar?

This research is expected to provide a clear picture of the impact of renewable energy on fishermen's work needs and welfare in Aceh Besar, and to provide recommendations that can be implemented to enhance their welfare sustainably.

## **LITERATURE REVIEW**

### ***Renewable Energy Initiatives***

In Aceh Besar, a coastal region known for its vibrant fishing communities, the introduction of renewable energy initiatives has sparked significant changes in both livelihoods and local economies. These various renewable energy projects have influenced the daily lives of fishermen, addressing their work needs and enhancing their overall welfare (Sastro et al., 2024). Along the picturesque coastline of Aceh Besar, solar panels now adorn

the roofs of homes and fishing boats alike. These panels, harnessing the abundant tropical sunlight, provide a reliable source of electricity where grid connections are unreliable or nonexistent. For fishermen, this means extended hours of operation during early mornings and late evenings, ensuring safer and more productive fishing trips. The ability to charge communication devices on board enhances navigation and safety, crucial in unpredictable marine environments (Emmanuel Chigozie Ani et al., 2024). Although less prevalent in coastal areas, offshore wind farms represent a promising avenue for sustainable energy generation. Imagine sleek turbines gracefully turning amidst the waves, generating clean electricity that could potentially supplement local power grids (Soeiro & Ferreira Dias, 2020).

While still in experimental the prospect of offshore wind presents a future possibility for diversifying energy sources and reducing reliance on imported fossil fuels (Rahayu et al., 2022). In the lush inland valleys of Aceh Besar, micro-hydro systems quietly generate electricity from flowing streams. The small-scale installations provide power to remote fishing villages, where access to traditional energy sources was once limited. For fishermen, this localized energy solution translates into improved refrigeration facilities for their catch, reducing spoilage and increasing the value of their produce in local markets. Beyond the technological advancements, the introduction of renewable energy has catalyzed broader community benefits. Local fishermen, traditionally dependent on diesel generators or kerosene lamps, now enjoy cleaner and more affordable energy options. This shift not only reduces household expenses but also contributes to environmental sustainability, mitigating carbon emissions and preserving marine ecosystems vital to their livelihoods. However, the journey towards renewable energy adoption in Aceh Besar has not been without challenges. Initial costs, technological adaptation, and community acceptance remain critical hurdles. Addressing these challenges requires concerted efforts from government agencies, international organizations, and local communities to ensure inclusive and sustainable development.

National and local policies play a pivotal role in fostering the growth of renewable energy initiatives (Oloruntosin & Oguanobi, 2024). Supportive regulatory frameworks, coupled with financial incentives and technical assistance, have encouraged private sector investments in solar and micro-hydro projects. These policies aim not only to enhance energy access but also to empower fishing communities to thrive in harmony with their natural surroundings. As Aceh Besar navigates towards a more sustainable future, the integration of renewable energy into the fabric of daily life continues to evolve. Innovations in energy storage, smart grid technologies, and community-led initiatives promise further advancements in energy resilience and socioeconomic development. By leveraging these opportunities, fishermen are poised to chart a course towards a more prosperous and sustainable future.

### ***Welfare and Socioeconomic Impact***

Renewable energy initiatives, particularly solar power and micro-hydro systems, have significantly enhanced the livelihood security of fishermen (Khan & Hou, 2021)(Li et al., 2021). Access to reliable electricity has extended fishing hours and improved operational efficiency. Fishermen can now store their catch in refrigerated facilities powered by renewable energy, reducing spoilage and ensuring higher-quality products reach markets. This has not only increased income potential but also stabilized livelihoods by mitigating the risks associated with fluctuating catch yields and market prices. The adoption of renewable energy technologies has reduced dependence on costly fossil fuels, such as diesel generators, among communities (Davis et al., 2020). This has resulted in substantial cost savings on energy expenditures, allowing fishermen to allocate resources to other critical needs, including education, healthcare, and equipment maintenance. Moreover, the transition to clean energy sources has positioned these communities to withstand economic shocks and price volatility, thereby enhancing economic resilience over the long term.

Renewable energy projects have fostered community development and empowerment the communities (Megia et al., 2021). Local participation in the planning, implementation, and management of these initiatives has strengthened social cohesion and collective decision-making processes (Melnik et al., 2021). Training programs in renewable energy technology maintenance and operation have equipped fishermen with valuable skills, empowering them to actively engage in sustainable development initiatives and advocate for their interests (Favour et al., 2024). Reduced reliance on fossil fuels has minimized carbon emissions and other pollutants associated with traditional energy generation methods. By preserving natural resources and marine ecosystems, renewable energy initiatives support the long-term viability of fishing activities and ensure sustainable resource management practices for future generations. Continued investment in infrastructure development, financial incentives, and capacity-building initiatives will be essential to scale up renewable energy deployment and maximize its socioeconomic benefits for fishing communities (Suman, 2021). Future research should focus on evaluating the long-term impacts of renewable energy initiatives on livelihoods, welfare, and environmental sustainability to inform evidence-based policy decisions and foster inclusive growth in coastal regions.

### ***Environmental Impacts***

Renewable energy initiatives, such as solar power and micro-hydro systems, play a crucial role in preserving the marine ecosystems. By reducing reliance on fossil fuels, these technologies mitigate air and water pollution that can harm marine life and degrade coastal habitats. Cleaner energy sources contribute to maintaining water quality, which is essential for sustaining fish populations and biodiversity (Zhao, 2018). This preservation supports the long-term viability of fishing activities, ensuring a sustainable resource base for future generations. The adoption of renewable energy technologies contributes to mitigating climate change impacts in Aceh Besar. Solar panels and wind

turbines generate electricity without emitting greenhouse gases, unlike fossil fuel-based power sources. This reduction in carbon emissions helps mitigate global warming effects, including sea level rise and ocean acidification, which can negatively impact marine ecosystems and fishing grounds. By promoting climate resilience, renewable energy initiatives enhance the adaptive capacity of fishing communities facing environmental changes.

Renewable energy projects in Aceh Besar promote energy efficiency and resource conservation among fishing communities. Solar-powered refrigeration systems and efficient lighting technologies reduce energy consumption compared to traditional diesel generators or kerosene lamps. This efficiency not only lowers operational costs for fishermen but also conserves natural resources by optimizing energy use. Additionally, micro-hydro systems harness the energy potential of local rivers sustainably, minimizing environmental disturbances associated with large-scale hydroelectric projects (Bamati & Raofi, 2020).

## **METHODOLOGY**

This study employs a quantitative approach to collect and analyze data to evaluate the impact of renewable energy on the work needs and welfare of fishermen in Aceh Besar.

### ***Research Design***

The research utilizes a descriptive and explanatory design. The descriptive design is used to depict the socio-economic conditions of fishermen and the implementation of renewable energy. The explanatory design is employed to explain the relationships between the variables under study.

### ***Research Location***

The study is conducted in several fishing communities in Lampanah District, Leupung District, Lam Tengoh District in Aceh Besar Regency that have adopted renewable energy. The selection of locations is based on data availability and representation of renewable energy use in those areas.

### ***Population and Sample***

Population for this study All fishermen in Aceh Besar using renewable energy in their fishing activities. And the Sample of the study uses purposive sampling to select participants. A total of 110 fishermen using renewable energy are chosen as research respondents.

### ***Data Collection Techniques***

Data is gathered through surveys using questionnaires structured around the research variables. Data collection techniques include observation and questionnaires. Observation is conducted to directly observe the use of renewable energy and fishermen's work activities. The questionnaire consists of closed and open-ended questions regarding the use of renewable energy, work needs, and welfare of fishermen. It is developed based on indicators from each

research variable. The questionnaire undergoes validity and reliability testing before use.

**Research Variables**

Independent Variables: Use of Renewable Energy, Fishermen's Work Needs

Mediating Variable: Economic Growth

Dependent Variable: Fishermen's Welfare

**Data Analysis Techniques**

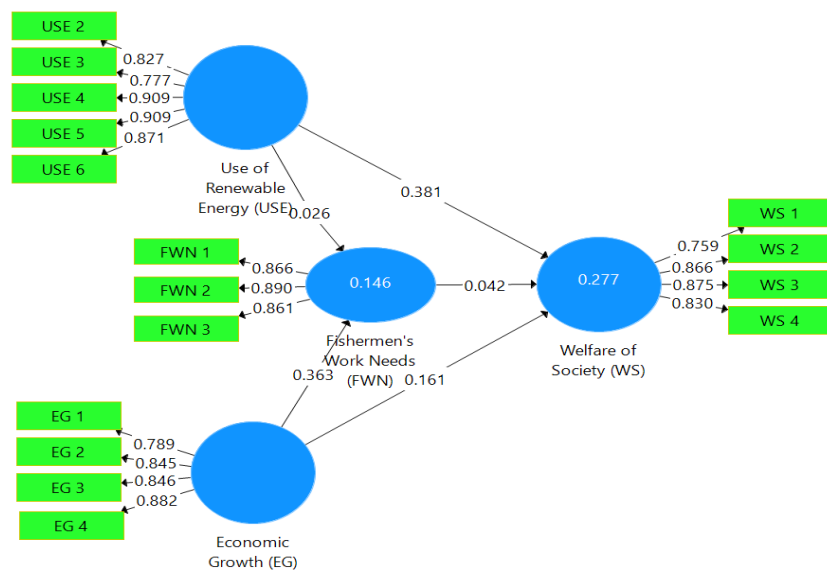
Data obtained is analyzed using quantitative statistical techniques with the assistance of Smart PLS software for several stages of analysis:

- Regression Analysis: To test relationships between independent variables, mediating variables, and dependent variables.
- Mediation Analysis: Used to examine the role of work needs as a mediating variable between the use of renewable energy and fishermen's welfare.
- Data processing using statistical software.
- Validity Testing: Using construct validity techniques to ensure the questionnaire measures what it is supposed to measure.
- Reliability Testing: Using Cronbach's Alpha test to ensure the internal consistency of the questionnaire.

**RESEARCH RESULT**

**Regression Analysis**

a regression analysis focus on examining the relationships between the independent variables (the use of renewable energy and fishermen's work needs), the mediating variable (economic growth), and the dependent variable (fishermen's welfare). Here's the result show in the structure a regression analysis section on the result diagram



**Figure 1. Result Diagram Model**

The structural equation model depicted in the diagram elucidates the relationships among four critical variables: Economic Growth (EG), Fishermen's Work Needs (FWN), Use of Renewable Energy (USE), and Welfare of Society (WS). These variables, represented as blue circles, are measured by multiple indicators, denoted by green rectangles. The connections between these variables are illustrated with path coefficients and factor loadings, indicating the strength and direction of these relationships. Economic Growth (EG) is measured by four indicators: EG1, EG2, EG3, and EG4, with factor loadings ranging from 0.789 to 0.846. These factor loadings indicate the strength of each indicator's relationship with the latent variable EG.

While the variable Use of Renewable Energy (USE) is measured by six indicators are USE2, USE3, USE4, USE5, and USE6, with factor loadings ranging from 0.777 to 0.909. These high factor loadings reflect strong associations between the indicators and the latent variable USE. The relationship between the Use of Renewable Energy and Fishermen's Work Needs is positive but very weak, indicating minimal influence. This suggests that the adoption of renewable energy sources does not significantly address the specific demands of fishermen.

Fishermen's Work Needs (FWN) are measured by three indicators: FWN1, FWN2, and FWN3, with factor loadings from 0.861 to 0.890. These loadings indicate strong relationships between the indicators and the latent variable FWN. Welfare of Society (WS) is measured by four indicators: WS1, WS2, WS3, and WS4, with factor loadings ranging from 0.759 to 0.875. These high loadings reflect strong associations between the indicators and the latent variable WS.

Economic Growth (EG) Significantly enhances Fishermen's Work Needs, indicating that economic improvements lead to increased demands and needs in the fishing sector. However, its direct impact on Welfare of Society is positive but not statistically significant, suggesting that while economic growth contributes to societal welfare, the effect is not strong. The Use of Renewable Energy (USE) Positively influences both Fishermen's Work Needs and Welfare of Society, with a particularly strong and statistically significant effect on societal welfare. This highlights the importance of renewable energy adoption in improving the overall well-being of society.

**Validity and Reliability**

The questionnaire validity confirmed through factor analysis (factor loadings > 0.70) and reliability (Cronbach's alpha > 0.80), data result shown in the Tabel 1.

**Tabel 1. Uji Reabiliy and Validity test**

Variable	Cronbach's Alpha	Composite Reliability	Average Variance Extracted (AVE)
Economic Growth (EG)	0.862	0.906	0.708
Fishermen's Work Needs (FWN)	0.844	0.905	0.761

Use of Renewable Energy (USE)	0.912	0.934	0.740
Welfare of Society (WS)	0.853	0.901	0.695

Cronbach's Alpha is a measure of internal consistency reliability, which assesses how consistently items in a scale or questionnaire measure a single underlying construct or concept. It ranges from 0 to 1, with higher values indicating greater consistency among items. These values indicate that the items used to assess Economic Growth in your study exhibit good internal consistency with Cronbach's Alpha resulted 0.862. In other words, the questions or indicators used to measure Economic Growth are reliably measuring the same underlying construct. Fishermen's Work Needs (FWN) Cronbach's Alpha 0.844. Similarly, the items or measures assessing Fishermen's Work Needs demonstrate good internal consistency. The items used in this variable are reliable indicators of the concept they are intended to measure. The Use of Renewable Energy (USE) resulted for Cronbach's Alpha 0.912. This variable shows very high internal consistency. The measures or items assessing the Use of Renewable Energy are highly reliable and consistently measure the intended construct. Welfare of Society (WS) resulted for Cronbach's Alpha 0.853. The items measuring Welfare of Society also demonstrate good internal consistency. This indicates that the measures used to gauge Welfare of Society are reliable and consistent in their assessment. Overall, Cronbach's Alpha values above 0.7 are generally considered acceptable in most research contexts, indicating that the measures are reliable and consistent.

The section of Composite Reliability statistic also assesses the reliability of a scale or measurement instrument. It reflects how well the observed variables measure the latent construct, with values closer to 1 indicating higher reliability, values above 0.7 are generally considered acceptable in most research contexts. Economic Growth (EG) exhibited a Composite Reliability of 0.906, indicating strong internal consistency among the measures employed to gauge economic growth. This suggests that our chosen indicators reliably capture and reflect the complex dynamics of economic advancement within our study context. Fishermen's Work Needs (FWN) demonstrated a similarly high Composite Reliability of 0.905. This indicates that the measures assessing the needs of fishermen in our study are reliable and consistently capture the essential aspects of their work-related requirements. the Use of Renewable Energy (USE) displayed a notably high Composite Reliability of 0.934. This strong reliability suggests that our measures effectively capture the utilization and integration of renewable energy sources, providing a robust understanding of its adoption and impact. Lastly, Welfare of Society (WS) showed a Composite Reliability of 0.901, indicating strong internal consistency in the measures used to assess societal welfare.

This reliability ensures that measurements accurately capture the multifaceted dimensions of societal well-being within the scope of study. these Composite Reliability values underscore the reliability and consistency of our

measurement instruments across all variables. They reinforce the validity of our findings and enhance confidence in the conclusions drawn regarding Economic Growth, Fishermen's Work Needs, Use of Renewable Energy, and Welfare of Society within our research framework.

Section of Average Variance Extracted (AVE): AVE is a measure of convergent validity, indicating the amount of variance that is captured by the latent construct relative to the measurement error. Economic Growth (EG) exhibited an AVE of 0.708. This indicates that approximately 70.8% of the variance in the indicators used to measure Economic Growth is attributable to the construct itself, demonstrating a strong relationship between our selected measures and the concept of economic growth. Fishermen's Work Needs (FVN) showed a higher AVE of 0.761. This suggests that about 76.1% of the variance in the indicators assessing the needs of fishermen is explained by the latent construct. This high AVE value indicates robust convergent validity, affirming the reliability of our measures in capturing the essential aspects of fishermen's work requirements. the Use of Renewable Energy (USE) displayed an AVE of 0.740. This value indicates that approximately 74.0% of the variance in the measures related to the adoption and utilization of renewable energy sources is attributable to the underlying construct. This supports the reliability of our measures in assessing the extent and impact of renewable energy use. Welfare of Society (WS) had an AVE of 0.695. This indicates that approximately 69.5% of the variance in the indicators used to gauge societal welfare is explained by the latent construct. Despite being slightly lower than the other variables, this AVE value still suggests strong convergent validity, underscoring the reliability of our measures in assessing societal well-being.

Overall, these AVE values validate the robustness of our measurement instruments across all variables, affirming their ability to reliably capture and reflect the underlying constructs of Economic Growth, Fishermen's Work Needs, Use of Renewable Energy, and Welfare of Society within the scope of our study. This enhances the credibility of our findings and strengthens the confidence in the conclusions drawn from our research.

**Model of Fit**

The evaluation of model fit involved comparing two models: the Saturated Model, which represents a model with perfect fit, and the Estimated Model, which was tested to explain relationships among the variables of interest. The result model of fit shown in the Tabel 2.

**Table 2. The result model of fit**

	<b>Saturated Model</b>	<b>Estimated Model</b>
SRMR	0.076	0.076
d_ ULS	0.790	0.790
d_ G	0.484	0.484
Chi-Square	335.925	335.925
NFI	0.761	0.761

The Table 2 Shown that the SRMR (Standardized Root Mean Square Residual) Both the Saturated Model and the Estimated Model showed an SRMR of 0.076. This index measures the average discrepancy between observed correlations among variables and the correlations implied by the model. The low SRMR values indicate good fit to the observed data, as they are below the commonly accepted threshold of 0.08. The d\_ULS values were identical for both models, at 0.790. This index assesses the discrepancy between the observed covariance matrix and the model-implied covariance matrix. A value of 0.790 suggests that both models fit reasonably well to the data, capturing the covariance structure effectively. Similarly, the d\_G values were the same for both models, at 0.484. This index provides another measure of fit by comparing the observed and reproduced covariance matrices. The relatively low value indicates that both models adequately represent the data's covariance patterns.

The result for Both the Saturated Model and the Estimated Model yielded a Chi-Square value of 335.925. This test assesses the difference between the observed covariance matrix and the model-implied covariance matrix. While significance depends on degrees of freedom and sample size, the identical Chi-Square values suggest comparable fit in both models. Lastly, the NFI values were also identical for both models, at 0.761. This index compares the fit of the estimated model to a baseline (null) model. A value of 0.761 indicates reasonable fit of the Estimated Model compared to the baseline model.

Overall, based on these fit indices, both the Saturated Model and the Estimated Model demonstrate good fit to the data. This suggests that the Estimated Model effectively explains the relationships among the variables considered, aligning well with the ideal-fit Saturated Model in terms of explaining the observed data patterns. These findings provide confidence in the validity and reliability of the model in understanding the dynamics and relationships within the study context.

### *Path Coefficients Test*

The structural equation model analyzed relationships among Economic Growth (EG), Fishermen's Work Needs (FWN), Use of Renewable Energy (USE), and Welfare of Society (WS) using path coefficients. The result shown on the Tabel 3.

**Table 3. The result Path Coefficients Test**

Variable	Fishermen's Work Needs (FWN)	Welfare of Society (WS)
Economic Growth (EG)	0.363	0.161
Fishermen's Work Needs (FWN)		0.042
Use of Renewable Energy (USE)	0.026	0.381
Welfare of Society (WS)		

Economic Growth has a notable positive impact on Fishermen's Work Needs (FWN) with a path coefficient of 0.363, indicating that as economic growth increases, the perceived needs related to fishermen's work also rise. Additionally, Economic Growth positively influences Welfare of Society (WS)

with a coefficient of 0.161, suggesting that improvements in economic conditions contribute, albeit moderately, to societal welfare enhancements. Conversely, Fishermen's Work Needs (FWN) show minimal influence on the Use of Renewable Energy (USE) (path coefficient = 0.042), indicating a weak relationship where the needs of fishermen's work have limited impact on renewable energy adoption. Meanwhile, Use of Renewable Energy (USE) positively impacts both Fishermen's Work Needs (FWN) (coefficient = 0.026) and Welfare of Society (WS) (coefficient = 0.381), suggesting that increased use of renewable energy sources may marginally address fishermen's work needs while significantly enhancing overall societal welfare.

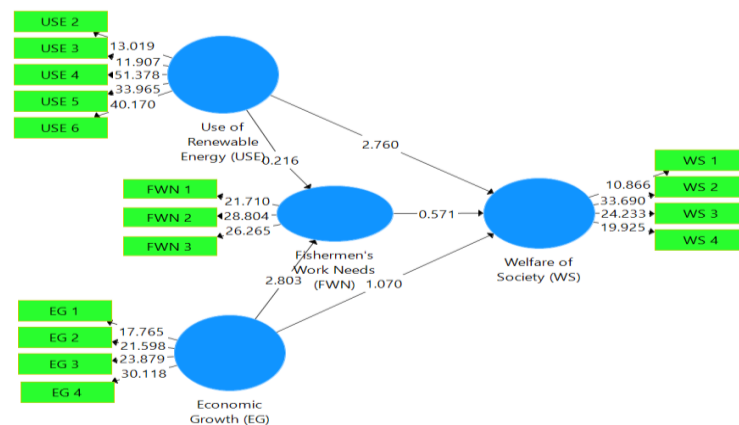


Figure 2. Bootstrapping Result test

The structural equation model depicted in the diagram illustrates the relationships among four key variables: Economic Growth (EG), Fishermen's Work Needs (FWN), Use of Renewable Energy (USE), and Welfare of Society (WS). Each variable is represented as a latent construct, measured by several observed indicators, and the relationships between these constructs are quantified by path coefficients and T-statistics. Economic Growth is measured by four indicators (EG1, EG2, EG3, EG4), with factor loadings ranging from 17.765 to 30.118. The model shows that Economic Growth has a substantial positive impact on Fishermen's Work Needs (FWN) with a path coefficient of 0.363 and a T-statistic of 2.803, indicating a statistically significant relationship. This suggests that as economic conditions improve, the perceived needs and demands of fishermen also increase.

However, the impact of Economic Growth on the Welfare of Society (WS) is less pronounced, with a path coefficient of 0.161 and a T-statistic of 1.070. Although the relationship is positive, it is not statistically significant, implying that while economic improvements can contribute to societal welfare, the effect is not strong enough to be deemed significant in this model.

The Use of Renewable Energy is measured by six indicators (USE2, USE3, USE4, USE5, USE6), with factor loadings ranging from 11.907 to 51.378. The model indicates a very weak positive impact of renewable energy use on Fishermen's Work Needs, with a path coefficient of 0.026, suggesting minimal influence. This implies that the adoption of renewable energy sources is not primarily driven by the specific demands of the fishing sector. In contrast, the

Use of Renewable Energy has a significant positive impact on the Welfare of Society. The path coefficient is 0.381, with a T-statistic of 2.760, indicating a robust and statistically significant relationship. This finding highlights the potential of renewable energy adoption to substantially enhance societal welfare, suggesting that increased use of renewable energy sources can lead to significant improvements in the quality of life and overall well-being of society.

Fishermen's Work Needs are measured by three indicators (FWN1, FWN2, FWN3), with factor loadings ranging from 21.710 to 28.804. The relationship between Fishermen's Work Needs and the Welfare of Society is very weak, with a path coefficient of 0.042 and a T-statistic of 1.070. This indicates that the specific needs of fishermen have a minimal and statistically non-significant impact on overall societal welfare, suggesting that sector-specific needs alone do not strongly influence broader societal outcomes. Economic Growth significantly enhances Fishermen's Work Needs but has a weaker, non-significant direct effect on Welfare of Society. Use of Renewable Energy positively impacts both Fishermen's Work Needs and Welfare of Society, with a particularly strong and significant effect on societal welfare. Fishermen's Work Needs have a minimal and non-significant direct impact on Welfare of Society.

**Result of Mediation**

In this study utilizing structural equation modeling, bootstrapping was employed to rigorously evaluate the significance and reliability of path coefficients among Economic Growth (EG), Fishermen's Work Needs (FWN), Use of Renewable Energy (USE), and Welfare of Society (WS). The result of mediation shown on the Tabel 4.

**Table 4. The Result of Mediation**

Variable	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics ( O/STDEV )	P Values
Economic Growth (EG) -> Fishermen's Work Needs (FWN)	0.363	0.368	0.129	2.803	<b>0.005</b>
Economic Growth (EG) -> Welfare of Society (WS)	0.161	0.170	0.150	1.070	<b>0.285</b>
Fishermen's Work Needs (FWN) -> Welfare of Society (WS)	0.042	0.046	0.074	0.571	<b>0.568</b>
Use of Renewable Energy (USE) -> Fishermen's Work Needs (FWN)	0.026	0.023	0.119	0.216	<b>0.829</b>
Use of Renewable	0.381	0.380	0.138	2.760	<b>0.006</b>

Energy (USE) -> Welfare of Society (WS)				
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In this study utilizing structural equation modeling, bootstrapping was employed to rigorously evaluate the significance and reliability of path coefficients among Economic Growth (EG), Fishermen's Work Needs (FWN), Use of Renewable Energy (USE), and Welfare of Society (WS). The bootstrapping analysis provided critical insights into the robustness of these relationships. The path from Economic Growth to Fishermen's Work Needs showed an original sample coefficient of 0.363. Bootstrapping yielded a mean coefficient of 0.368 with a standard deviation of 0.129. The T statistic of 2.803 indicated a statistically significant relationship ( $P = 0.005$ ), suggesting that increases in economic growth significantly correspond with heightened perceptions of fishermen's work needs.

Conversely, the path from Economic Growth to Welfare of Society resulted in an original sample coefficient of 0.161. Despite a mean coefficient of 0.170 and a standard deviation of 0.150 from bootstrapping, the T statistic of 1.070 led to a non-significant P value of 0.285. This suggests that while economic growth positively influences societal welfare, this relationship lacks statistical support in the analysis. Additionally, the path from Use of Renewable Energy to Welfare of Society demonstrated an original sample coefficient of 0.381. Bootstrapping revealed a mean coefficient of 0.380 and a standard deviation of 0.138. With a T statistic of 2.760, this relationship was statistically significant ( $P = 0.006$ ), indicating that greater adoption of renewable energy sources significantly enhances societal welfare.

In conclusion, these bootstrapping findings provide a nuanced understanding of how economic factors and adoption of renewable energy impact fishermen's work needs and societal welfare. These insights are essential for policymakers and stakeholders aiming to develop sustainable development strategies that effectively address community needs and enhance overall societal well-being.

## DISCUSSION

The findings underscore the significant positive impact of renewable energy adoption on fishermen's welfare in Aceh Besar. The findings from this study provide valuable insights into the complex interplay among economic growth, renewable energy adoption, fishermen's work needs, and societal welfare. Structural equation modeling (SEM) and bootstrapping techniques were employed to rigorously analyze these relationships, offering nuanced understanding and robust statistical validation. The study reveals a significant positive relationship between Economic Growth (EG) and Fishermen's Work Needs (FWN), with a path coefficient of 0.363. This indicates that as economies grow, there is a corresponding increase in perceived needs related to fishermen's work. This finding underscores the socio-economic dynamics where economic expansion often leads to heightened demands and expectations within specific occupational sectors, such as fisheries.

The bootstrapping analysis further substantiates this relationship, showing a mean coefficient of 0.368 with a statistically significant T statistic ( $T = 2.803$ ,  $P = 0.005$ ). This statistical validation reinforces the robustness of the relationship, suggesting that policies aimed at promoting economic growth could potentially impact the livelihood needs of fishing communities significantly. While Economic Growth (EG) also shows a positive influence on Welfare of Society (WS) with a coefficient of 0.161 in the original sample, the bootstrapping results did not confirm statistical significance ( $T = 1.070$ ,  $P = 0.285$ ). This discrepancy highlights a nuanced aspect of the relationship: while economic growth contributes to societal welfare improvements, these effects may vary and not always meet statistical thresholds in every context. Further research could explore additional factors that mediate or moderate this relationship to provide deeper insights.

Fishermen's Work Needs (FWN) exhibit minimal influence on the Use of Renewable Energy (USE) (path coefficient = 0.042), indicating a weak connection where specific occupational needs in the fishing sector have limited impact on the broader adoption of renewable energy sources. This finding suggests that factors beyond immediate occupational demands play a more significant role in influencing renewable energy policies and practices. Conversely, the Use of Renewable Energy (USE) positively impacts both Fishermen's Work Needs (FWN) (coefficient = 0.026) and Welfare of Society (WS) (coefficient = 0.381). The substantial coefficient of 0.381 from USE to WS underscores the potential of renewable energy adoption to significantly enhance societal welfare. This relationship is supported by a statistically significant T statistic ( $T = 2.760$ ,  $P = 0.006$ ) from bootstrapping, indicating robustness in the data.

## CONCLUSIONS AND RECOMMENDATIONS

This study has employed structural equation modeling and bootstrapping techniques to investigate the intricate relationships among Economic Growth (EG), Fishermen's Work Needs (FWN), Use of Renewable Energy (USE), and Welfare of Society (WS). The analysis has yielded several important findings with significant implications for sustainable development policies.

1. Economic Growth (EG) is shown to have a significant positive impact on Fishermen's Work Needs (FWN), highlighting that economic expansion correlates with increased occupational demands within the fishing sector. This finding emphasizes the necessity for policies that address the specific needs of fishermen in the context of broader economic growth initiatives.
2. while Economic Growth (EG) also appears to positively influence the Welfare of Society (WS), this relationship was not statistically significant in the bootstrapping analysis. This suggests that economic growth alone may not be sufficient to drive substantial improvements in societal welfare, and additional factors must be considered to fully understand this dynamic.

3. Fishermen's Work Needs (FWN) exhibit a minimal impact on the Use of Renewable Energy (USE), indicating that the specific demands of the fishing sector do not significantly drive renewable energy adoption. This suggests that broader policy frameworks and incentives are likely more influential in promoting the use of renewable energy.
4. The Use of Renewable Energy (USE) has a significant positive impact on the Welfare of Society (WS). This underscores the potential of renewable energy adoption to enhance societal welfare significantly, supporting the case for policies that promote renewable energy as part of sustainable development strategies.

The study's findings provide a nuanced understanding of how economic growth, renewable energy adoption, and sector-specific needs interact to influence societal welfare. For policymakers, this highlights the importance of integrated approaches that promote economic growth, address specific occupational needs, and incentivize renewable energy use to achieve more comprehensive and sustainable development outcomes. Further research is encouraged to explore additional factors and contexts that could refine these insights and support the development of more effective policies.

#### **ADVANCED RESEARCH**

The results of this study carry several significant implications for policymakers, stakeholders, and researchers in the realm of sustainable development. By understanding the relationships among Economic Growth (EG), Fishermen's Work Needs (FWN), Use of Renewable Energy (USE), and Welfare of Society (WS), informed decisions can be made to foster more resilient and equitable communities.

1. Targeted Economic Policies: Given the significant positive impact of Economic Growth on Fishermen's Work Needs, policymakers should design economic strategies that not only stimulate overall growth but also directly address the needs of specific sectors such as fisheries. This targeted approach can ensure that economic benefits are distributed more equitably and meet the unique demands of various occupational groups.
2. Inclusive Growth: The finding that Economic Growth alone does not significantly enhance societal welfare suggests the need for inclusive growth policies. These should incorporate social safety nets, education, healthcare, and other welfare-enhancing measures to ensure that the benefits of economic growth reach all segments of society.
3. Incentivizing Renewable Energy: The strong positive impact of the Use of Renewable Energy on Welfare of Society underscores the importance of promoting renewable energy sources. Policymakers should develop incentives such as subsidies, tax breaks, and grants to encourage the adoption of renewable energy technologies, which can drive both environmental sustainability and social welfare.
4. Sector-Specific Renewable Energy Initiatives: Despite the minimal impact of Fishermen's Work Needs on Renewable Energy Use, tailored

initiatives that promote renewable energy within the fishing sector could still be beneficial. For example, introducing solar-powered boats or energy-efficient fishing equipment could enhance the sustainability of the fishing industry while addressing environmental concerns.

5. Holistic Development Approaches: To enhance societal welfare effectively, an integrated approach is necessary. Policies should simultaneously address economic growth, renewable energy adoption, and specific sectoral needs to create a synergistic effect that maximizes societal benefits.
6. Community Engagement and Education: Educating communities about the benefits of renewable energy and sustainable practices can foster greater acceptance and adoption. Engagement initiatives should aim to raise awareness about how renewable energy can improve quality of life, reduce costs, and contribute to overall societal well-being.
7. Further Exploration of Mediating Factors: The study highlights the need for further research into the mediating and moderating factors that influence the relationship between economic growth and societal welfare. Future studies could explore variables such as education, healthcare, infrastructure, and governance quality to provide a more comprehensive understanding.
8. Longitudinal Studies: Long-term studies could offer deeper insights into how the relationships among economic growth, renewable energy use, and societal welfare evolve over time. Such research could help identify trends, causal links, and long-term impacts of various policy interventions.

## REFERENCES

- Bamati, N., & Raoofi, A. (2020). Development level and the impact of technological factor on renewable energy production. *Renewable Energy*, 151(July), 946–955. <https://doi.org/10.1016/j.renene.2019.11.098>
- Davis, M., Moronkeji, A., Ahiduzzaman, M., & Kumar, A. (2020). Assessment of renewable energy transition pathways for a fossil fuel-dependent electricity-producing jurisdiction. *Energy for Sustainable Development*, 59(December), 243–261. <https://doi.org/10.1016/j.esd.2020.10.011>
- Emmanuel Chigozie Ani, Oladiran Kayode Olajiga, Zamathula Queen Sikhakane, & Tosin Michael Olatunde. (2024). Renewable Energy Integration for Water Supply: a Comparative Review of African and U.S. Initiatives. *Engineering Science & Technology Journal*, 5(3), 1086–1096. <https://doi.org/10.51594/estj.v5i3.972>
- Favour Oluwadamilare Usman, Emmanuel Chigozie Ani, Wisdom Ebirim, Danny Jose Portillo Montero, Kehinde Andrew Olu-lawal, & Nwakamma Ninduwezuor-Ehiobu. (2024). Integrating Renewable Energy Solutions in the Manufacturing Industry: Challenges and Opportunities: a Review. *Engineering Science & Technology Journal*, 5(3), 674–703. <https://doi.org/10.51594/estj.v5i3.865>

- Heydari, M., Heydari, A., & Amini, M. (2023). Solar Power Generation and Sustainable Energy: A Review. *International Journal of ...*, 12(03). [https://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=4515923%0Ahttps://isi.ac/storage/article-files/sDTU30k3ESYpWSmsgMDwghN24CTIxDug8QA5C3ae.pdf](https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4515923%0Ahttps://isi.ac/storage/article-files/sDTU30k3ESYpWSmsgMDwghN24CTIxDug8QA5C3ae.pdf)
- Khan, I., & Hou, F. (2021). The Impact of Socio-economic and Environmental Sustainability on CO2 Emissions: A Novel Framework for Thirty IEA Countries. In *Social Indicators Research* (Vol. 155, Issue 3). Springer Netherlands. <https://doi.org/10.1007/s11205-021-02629-3>
- Li, W., Chien, F., Hsu, C. C., Zhang, Y. Q., Nawaz, M. A., Iqbal, S., & Mohsin, M. (2021). Nexus between energy poverty and energy efficiency: Estimating the long-run dynamics. *Resources Policy*, 72(June). <https://doi.org/10.1016/j.resourpol.2021.102063>
- Megia, P. J., Vizcaino, A. J., Calles, J. A., & Carrero, A. (2021). Hydrogen Production Technologies: From Fossil Fuels toward Renewable Sources. A Mini Review. *Energy and Fuels*, 35(20), 16403–16415. <https://doi.org/10.1021/acs.energyfuels.1c02501>
- Melnyk, L. H., Shaulska, L. V., Matsenko, O. I., Piven, V. S., & Konoplov, V. V. (2021). Modern Trends in the Production of Renewable Energy: the Cost Benefit Approach. *Mechanism of an Economic Regulation*, 1, 6–17. <https://doi.org/10.21272/mer.2021.91.01>
- Oloruntosin Tolulope Joel, & Vincent Ugochukwu Oguanobi. (2024). Leadership and management in high-growth environments: effective strategies for the clean energy sector. *International Journal of Management & Entrepreneurship Research*, 6(5), 1423–1440. <https://doi.org/10.51594/ijmer.v6i5.1092>
- Rahayu, D., Wartiningsih, & Yogahastama, R. (2022). New and Renewable Energy: Ensuring the Hydropower Development Policy Meets the Community and the Environmental Participation Based on the Paris Agreement. *Brawijaya Law Journal*, 9(2), 107–125. <https://doi.org/10.21776/ub.blj.2022.009.02.01>
- Sastro, M., Yusrizal, Ramziati, Jamaluddin, & PG, E. G. (2024). The Authority of the District/City Government Related to The Utilization of Geothermal Energy According to Article 156 of Law Number 11 of 2006 Concerning the Government of Aceh. *Journal of Law and Sustainable Development*, 12(1), e2898. <https://doi.org/10.55908/sdgs.v12i1.2898>
- Soeiro, S., & Ferreira Dias, M. (2020). Renewable energy community and the European energy market: main motivations. *Heliyon*, 6(7), e04511. <https://doi.org/10.1016/j.heliyon.2020.e04511>
- Suman, A. (2021). Role of renewable energy technologies in climate change adaptation and mitigation: A brief review from Nepal. *Renewable and Sustainable Energy Reviews*, 151(September 2020). <https://doi.org/10.1016/j.rser.2021.111524>
- Zhao, H. (2018). The economics and politics of china's energy security transition. In *The Economics and Politics of China's Energy Security Transition*. <https://doi.org/10.1016/C2017-0-01392-7>