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Accelerating Hydropower Investment for Economic Growth in North Tapanuli, Indonesia

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ABSTRACT

This study aims to analyze the influence of infrastructure availability, human resources, tax incentives, political stability, and the investment climate on accelerating investment in the renewable energy sector—specifically hydropower—and regional economic development in North Tapanuli Regency. The study involved a saturated sample of 308 respondents: hydropower investors from 23 project sites, government officials, and local communities. Data analysis was conducted using both descriptive and quantitative methods. The findings reveal that infrastructure availability, human resources, tax incentives, political stability, and the investment climate all significantly influence the acceleration of investment in the renewable energy sector (hydropower) and regional economic development, both partially and simultaneously, in North Tapanuli. Human resources and political stability have the most substantial impact on these variables. High-quality human resources contribute to productivity and innovation, attracting investors, while political stability creates an optimal environment for investment—both critical for regional economic growth. This research serves as a vital foundation for creating a conducive investment climate, accelerating regional economic development, and fostering sustainable opportunities for future economic growth.

Keywords: Acceleration of investment, hydroelectric power plants, regional economic development

1. Introduction

Fulfilling the country's energy requirements is essential to achieving national energy resilience. Energy security refers to the assurance of energy availability, including accessible and affordable energy for the public over the long term while maintaining environmental sustainability. Since 2004, Indonesia has become a net oil importer due to increasing domestic demand and declining oil production. The rise in oil consumption is closely linked to economic growth and population expansion. To address this burden, the government continues subsidizing energy through the national budget, which places significant pressure on public finances. To reduce this burden, Indonesia is striving to decrease its dependence on fossil fuels by exploring and developing alternative energy sources that are both affordable and accessible—namely, new and renewable energy (NRE).

Around 87% of Indonesia's energy supply comes from fossil fuels such as oil, coal, and natural gas (Ministry of Energy and Mineral Resources, 2023). According to the National Energy Council (2020), over 60% of energy consumed by Indonesia's population originates from fossil fuel sources, with household electricity being one of the most significant usage sectors. From 2015 to 2019, electricity consumption in Indonesia increased annually across all user sectors, with an average national electricity consumption growth rate of 5.7% per year (PLN, 2020). It is projected that electricity demand will continue to rise at an annual rate of 6.42% over the next decade, assuming economic growth of 6.3% per year.

Using fossil fuels for electricity and transportation contributes significantly to global warming and climate change, posing threats to life and the environment. Fossil fuel combustion releases carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O), all of which are major contributors to greenhouse gas (GHG) emissions. Based on GHG emission data by sector from 2000 to 2019, the energy sector is the largest emitter (BPS, 2022). By 2030, the energy sector will produce 1,669 million tons of CO_2 emissions (IEA, 2021).

In response, the Indonesian government has committed to reducing emissions by 29–41% by 2030 through initiatives such as cofiring, coal gasification, and other technologies (Aditya et al., 2022). Given the urgent need to control carbon emissions in the face of climate change, renewable energy has become a crucial solution to meet energy demands without degrading ecosystems (Hua et al., 2016). This situation has prompted the government to accelerate the transition from fossil fuels to renewable energy. Accelerated energy policy reforms are needed to address rising energy and electricity demands and increasing climate risks (Ardiansyah, 2022).

In alignment with the National Energy Policy outlined in Government Regulation No. 79/2014, Indonesia targets a minimum of 23% renewable energy share in its national energy mix by 2025 and 31% by 2050. However, the current renewable energy mix stands at only 12.3%. This gap in target realization threatens Indonesia's ability to reduce carbon emissions in the coming decades. Increasing the share of NRE is a national priority and a global commitment. Under the 2015 Paris Agreement, Indonesia committed to preventing global temperature rise from exceeding 1.5°C above pre-industrial levels and aims to achieve net-zero emissions (NZE) by 2050. To reach its 2025 targets, the government has outlined a 42 GW renewable energy investment plan sourced from geothermal, hydropower, mini-hydro, micro-hydro, bioenergy, solar, and wind.

North Tapanuli Regency possesses significant untapped water resources, particularly along the Sibundong River, which have high potential as a primary source of renewable energy (Ulfah, 2017). This hydropower potential is strategically intended to support energy needs in Lake Toba's National Tourism Strategic Area (Ginanjar, 2020). Over the past decade (2013–2022), the region has identified 23 hydropower potential sites. Of these, only three have entered the operational stage, three are under construction, and the remaining 17 sites have yet to progress beyond the planning phase.

The substantial gap between projected and realized investment in the renewable energy sector, particularly in hydropower, amounts to IDR 13.7 trillion, representing both a significant opportunity and a challenge for local government authorities in North Tapanuli. Understanding how to accelerate investment in this sector is crucial for unlocking its full economic potential.

This study is essential for supporting investment acceleration and regional economic development. It specifically aims to analyze the key factors influencing the acceleration of renewable energy investment—focusing on hydropower—and its contribution to economic development in North Tapanuli Regency.

2. Methods

This study employs an explanatory research design using a quantitative approach. Explanatory research aims to test hypotheses regarding the relationships or effects between two or more variables, as developed based on existing theories (Mulyadi, 2019). The quantitative approach involves statistical data analysis to describe the data and test the established hypotheses (Sugiyono, 2018).

The research was conducted in North Tapanuli Regency across seven districts: Tarutung, Siatas Barita, Pahae Julu, Adiankoting, Siborong-borong, Garoga, and Parmonangan. Primary data were collected from a population of 308 respondents. The study used a saturated sampling technique (census sampling), where the entire population was included as the sample. Thus, the total sample consisted of 308 individuals, including investors, government officials, regional apparatus, and representatives of the local community. Data collection was carried out over a three-month period from November 2023 to January 2024. Primary data were gathered through interviews using structured questionnaires, while secondary data were collected through document analysis related to renewable energy investment and relevant policy frameworks supporting the acceleration of hydropower development.

2.1 Research Variables
Research variables refer to all measurable elements defined by the researcher to obtain information and draw conclusions about a specific phenomenon (Sugiyono, 2018). This study included five independent variables: infrastructure availability (X1), human resources (X2), tax incentives (X3), political stability (X4), and the investment climate (X5). These variables were analyzed in relation to two dependent variables: the acceleration of investment in the renewable energy sector—specifically hydropower (Z), and regional economic development (Y) in North Tapanuli Regency.

2.2 Data Analysis Method
This study used both descriptive and quantitative data analysis techniques. Descriptive analysis was employed to summarize and describe the collected data, while quantitative analysis involved the use of statistical regression models. The regression analysis aimed to identify and measure the influence of each research variable on the acceleration of investment and regional economic development.

3. Result and Discussion

3.1. Infrastructure Availability (X1) and Investment Acceleration (Z)
Interviews revealed that 39.0% of respondents stated that the local government had built roads extending to rural areas. However, the responses indicate that the government has not fully supported infrastructure development. The analysis shows that infrastructure availability has a positive and significant partial effect ($0.047 < 0.05$) on investment acceleration (Table 1). The Pearson correlation value between infrastructure availability and investment acceleration is 0.387 (38.7%), indicating a positive relationship. The Sig. (2-tailed) value is $0.000 < 0.05$, confirming a significant correlation between these two variables (Table 2).

These findings suggest that infrastructure availability positively and significantly influences investment acceleration. This result aligns with Munawaroh (2020), who found that infrastructure development significantly impacts economic growth and investment acceleration. Similarly, Yang et al. (2020) concluded that road infrastructure investment contributes to economic improvement and supports investment growth in many countries and regions.

3.2. Human Resources (X2) and Investment Acceleration (Z)
Interview results show that 38.0% of respondents reported the presence of local graduates with undergraduate degrees. Nevertheless, the findings indicate that qualified human resources remain limited to support investment acceleration efforts fully. The human resources variable has a positive and significant partial effect ($0.000 < 0.05$) on investment acceleration (Table 1). The Pearson correlation coefficient is 0.538 (53.8%), indicating a strong positive relationship. The Sig. (2-tailed) value of $0.000 < 0.05$ confirms a statistically significant correlation (Table 2).

Thus, human resources significantly and positively impact investment acceleration. This supports the findings by Nursyadza and Maria (2023), who concluded that human development indices and labor availability significantly influence economic growth and investment acceleration. Le et al. (2019) also found that foreign direct investment and human capital positively affect long-term labor productivity. These findings imply that policymakers must establish concrete strategies to enhance human capital to support investment acceleration and sustainable development.

3.3. Tax Incentives (X3) and Investment Acceleration (Z)
About 33.8% of respondents stated that the government provides tax reductions and local fee exemptions. However, interviews suggest that tax incentives are not yet fully implemented to support investment acceleration effectively. The tax incentives variable has a positive and significant effect ($0.020 < 0.05$) on investment acceleration (Table 1). The Pearson correlation coefficient is 0.285 (28.5%), indicating a positive relationship, and the Sig. (2-tailed) value is $0.000 < 0.05$, confirming a significant correlation (Table 2).

In conclusion, tax incentives positively and significantly impact investment acceleration. These findings are consistent with Kurnia (2024), who emphasized that well-structured tax incentive policies play a vital role in strengthening the investment climate. Adequately designed incentives can attract investors; legal protection for investors receiving such incentives is equally essential. The government must ensure that regulations are clear and effectively enforceable to protect investor rights.

3.4. Political Stability (X4) and Investment Acceleration (Z)

Interviews show that 40.9% of respondents believe that the executive, legislative, and judicial branches maintain a stable political environment, although some noted instability at the community level. These responses suggest that political stability is not yet entirely conducive to accelerating investment. The political stability variable shows a positive and significant effect (0.000 < 0.05) on investment acceleration (Table 1). The Pearson correlation value is 0.517 (51.7%), indicating a strong positive relationship. The Sig. (2-tailed) value is 0.000 < 0.05, confirming the significance of this correlation (Table 2).

This indicates that political stability has a significant positive effect on investment acceleration. This finding aligns with Alam et al. (2019), who concluded that political instability negatively affects investment. Governments must maintain institutional stability and strengthen corporate-level factors to create a healthy investment environment, as institutional factors play a key role in explaining variations over time and are cost-effective in implementation.

3.5. Investment Climate (X5) and Investment Acceleration (Z)

According to 39.6% of respondents, local investment regulations are in place and known by investors, although many are still reviewing their rights and obligations. This indicates that the current investment climate is not yet fully supportive of accelerating investment. The investment climate variable has a positive and significant partial effect (0.007 < 0.05) on investment acceleration (Table 1). The Pearson correlation value is 0.307 (30.7%), indicating a positive relationship, while the Sig. (2-tailed) value is 0.000 < 0.05, confirming a statistically significant correlation (Table 2).

Therefore, the investment climate significantly and positively influences investment acceleration. These findings are consistent with Tarumingkeng (2024), who found that the investment climate affects both the attraction of investors and the encouragement of local investment. However, this contrasts with Mutia et al. (2019), who found that the existing investment climate has not yet effectively supported the implementation of green energy initiatives in Indonesia's power sector.

Tabel 1. Partial Test of Independent Variables on Accelerated Investment (Z)

Likelihood Ratio Tests

	Model Fitting Criteria	Likelihood Ratio Tests		
Effect	-2 Log Likelihood of Reduced Model	Chi-Square	df	Sig.
Intercept	1.363	.000	0	.
X1	1.863	49.999	12	.047
X2	2.108	74.436	16	.000
X3	1.904	54.078	12	.020
X4	2.109	74.596	16	.000
X5	2.096	73.230	16	.007

Tabel 2. Correlation Analysis Results

Correlations

		X1	X2	X3	X4	X5	Z	Y
X1	Pearson Correlation	1	.380**	.336**	.178**	.310**	.387**	.501**
	Sig. (2-tailed)		.000	.000	.002	.000	.000	.000
	N	308	308	308	308	308	308	308
X2	Pearson Correlation	.380**	1	-.105	.534**	.255**	.538**	.264**
	Sig. (2-tailed)	.000		.066	.000	.000	.000	.000
	N	308	308	308	308	308	308	308
X3	Pearson Correlation	.336**	-.105	1	-.146*	.234**	.285**	.107
	Sig. (2-tailed)	.000	.066		.010	.000	.000	.030
	N	308	308	308	308	308	308	308
X4	Pearson Correlation	.178**	.534**	-.146*	1	.461**	.517**	.387**
	Sig. (2-tailed)	.002	.000	.010		.000	.000	.000

Correlations

		X1	X2	X3	X4	X5	Z	Y
	N	308	308	308	308	308	308	308
X5	Pearson Correlation	.310**	.255**	.234**	.461**	1	.307**	.482**
	Sig. (2-tailed)	.000	.000	.000	.000		.000	.000
	N	308	308	308	308	308	308	308
Z	Pearson Correlation	.387**	.538**	.285**	.517**	.307**	1	.467**
	Sig. (2-tailed)	.000	.000	.000	.000	.000		.000
	N	308	308	308	308	308	308	308
Y	Pearson Correlation	.501**	.264**	.107	.387**	.482**	.467**	1
	Sig. (2-tailed)	.000	.000	.030	.000	.000	.000	
	N	308	308	308	308	308	308	308

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

The study confirms that five key factors—infrastructure, human resources, tax incentives, political stability, and the investment climate—each play a significant role in accelerating hydropower investment in North Tapanuli. When improved individually, these factors help attract renewable energy investments by creating more efficient systems, skilled labor, favorable policies, and a stable political environment.

Among these, human resources and political stability have the strongest influence. Skilled local workers and a peaceful, predictable political climate give investors greater confidence to invest long term. Overall, the findings suggest that successful hydropower development requires coordinated efforts across multiple sectors to create an environment where sustainable investment can thrive.

3.6. Infrastructure Availability (X1), Human Resources (X2), Tax Incentives (X3), Political Stability (X4), and Investment Climate (X5) with Investment Acceleration (Z)

The analysis of the -2 log-likelihood values shows that the model with only an intercept (no predictor variables) resulted in a value of 612.046. In contrast, the final model with all predictors produced a value of 257.094. This generates a chi-square value of 354.953 with a significance level of 0.000 < 0.05. These results indicate that infrastructure availability, human resources, tax incentives, political stability, and the investment climate simultaneously significantly and positively affect accelerating investment in the renewable energy sector (see Table 3).

Tabel 3. Independent Variables on Accelerated Investment (Z)

Model Fitting Information

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	612.046			
Final	257.094	354.953	19	.000

Table 3 shows that infrastructure availability, human resources, tax incentives, political stability, and the investment climate jointly play a significant and positive role in accelerating investment in the renewable energy sector, particularly hydropower, in North Tapanuli. This means that when these five factors are improved together, they can significantly boost investor confidence and speed up the realization of regional investment projects.

3.7. Infrastructure Availability (X1) and Regional Economic Development (Y) through Investment Acceleration (Z)

Interview results revealed that 39.0% of respondents stated the local government had built roads extending to village areas, and 43.5% noted that the government had facilitated investment promotion and licensing. However, respondents also highlighted that the government had not fully supported infrastructure development or helped resolve investment-related issues. Well-developed infrastructure serves as an incentive for investors by reducing investment costs. Statistical analysis further confirmed that infrastructure availability positively and significantly affects regional economic development through investment acceleration, with a coefficient of 2.570 (significance 0.034 < 0.05, Table 4). These findings align with

studies by Iqbal et al. (2019), Jemumu and Damayanti (2024), and Owusu-Manu et al. (2019), all of which confirmed that infrastructure significantly supports regional economic development. Moreover, electricity generation capacity is recognized as a key infrastructure indicator that positively influences economic growth.

3.8. Human Resources (X2) and Regional Economic Development (Y) through Investment Acceleration (Z)
According to interviews, 38.0% of respondents acknowledged the availability of local professionals with undergraduate degrees, and 32.8% believed hydropower projects contributed positively to the regional economy and local communities, though not necessarily for investors. However, the findings suggest that qualified human resources remain insufficient to support investment acceleration fully. Statistical results showed a strong positive and significant effect of human resources on regional economic development via investment acceleration, with a coefficient of 3.030 (significance 0.000 < 0.05, Table 4). These results align with research by Masruroh et al. (2023) and Xu and Li (2020), which emphasized that human capital is a key driver of economic growth, especially in regions with high openness and innovation capacity.

3.9. Tax Incentives (X3) and Regional Economic Development (Y) through Investment Acceleration (Z)
About 33.8% of respondents confirmed that the government provided tax and local fee reductions, and 32.8% stated that hydropower projects contributed positively to regional and community development, though not directly benefiting investors. Despite these efforts, respondents indicated that tax incentives had not been fully optimized to support investment. Statistical testing revealed a positive and significant effect of tax incentives on regional economic development through investment acceleration, with a coefficient of 2.657 (significance 0.000 < 0.05, Table 4). These findings are consistent with research by Melatnerbar et al. (2021) and Majid (2020), highlighting the importance of clear, consistent, and transparent tax policies for attracting investment in renewable energy. However, Ali and John (2018) found that tax incentives for multinational companies did not produce the expected investment outcomes, suggesting the need for a more supportive investment environment.

3.10. Political Stability (X4) and Regional Economic Development (Y) through Investment Acceleration (Z)
Interview data showed that 40.9% of respondents considered the political environment across the executive, legislative, and judiciary branches to be stable, although some noted social unrest in the community. Additionally, 32.8% believed hydropower projects positively influenced regional economic development. Still, respondents suggested that political stability was not conducive to accelerating investment. Statistical analysis confirmed that political stability significantly and positively affected regional economic development through investment acceleration, with a coefficient of 3.086 (significance 0.000 < 0.05, Table 4). These findings support studies by Melatnerbar et al. (2021) and Mansharamani (2023), which emphasized the importance of a stable political and social climate in attracting both foreign and domestic investors.

3.11. Investment Climate (X5) and Regional Economic Development (Y) through Investment Acceleration (Z)
According to 39.6% of respondents, local investment regulations were in place and known to investors, although many were still learning about their rights and responsibilities. Meanwhile, 32.8% stated that hydropower projects contributed to regional economic development. However, the overall investment climate was not considered fully supportive of investment acceleration. Statistical analysis demonstrated that the investment climate positively and significantly influenced regional economic development through investment acceleration, with a coefficient of 2.730 (significance 0.000 < 0.05, Table 4). These findings align with studies by Melatnerbar et al. (2021) and Salman et al. (2019), which emphasized that strong institutions and consistent government actions are vital in creating a healthy and competitive investment environment for sustainable growth.

3.12. Combined Effect of X1–X5 on Regional Economic Development (Y)
Simultaneously, the analysis of the -2 log-likelihood values indicated that the model with only an intercept had a value of 616.082, while the final model with predictor variables showed a value of 358.141. The resulting chi-square value was 257.941 with a significance level of 0.000 < 0.05. These findings confirm that infrastructure availability, human resources, tax incentives, political stability, and the investment climate together significantly and positively impact regional economic development in North Tapanuli (see Table 5).

Table 4. Partial Test of Independent Variables on Regional Economic Development (Y)

Effect	Model Fitting Criteria	Likelihood Ratio Tests		
	-2 Log Likelihood of Reduced Model	Chi-Square	Df	Sig.
Intercept	2.293	.000	0	.
X1	2.570	27.710	12	.034
X2	3.030	73.689	16	.000
X3	2.657	36.435	12	.000
X4	3.086	79.276	16	.000
X5	2.730	43.747	12	.000

Table 5. Independent Variables on Regional Economic Development (Y)

Model Fitting Information

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	616.082			
Final	358.141	257.941	19	.000

Table 4 demonstrates that each factor individually influences regional economic development through the acceleration of investment. For example, better infrastructure reduces investment costs, while skilled human resources improve productivity and innovation. A stable political environment and effective tax policies also contribute to a more attractive investment climate. The analysis reveals that human resources and political stability are the most influential among the five variables, acting as key drivers of investment and economic growth.

Table 5 confirms that when all five factors are combined, they collectively contribute to the region's economic development significantly and positively. This suggests that sustainable growth cannot rely on a single factor alone. Instead, coordinated improvements across infrastructure, education, governance, fiscal policy, and investment regulations are essential to support long-term economic progress.

4. Conclusions

This research confirms that infrastructure availability, human resources, tax incentives, political stability, and the investment climate each play a significant and active role in accelerating investment in the renewable energy sector, particularly in hydropower projects across North Tapanuli. Both individually and collectively, these five factors have a direct and positive impact on speeding up investment and enhancing regional economic development.

The findings reveal that human resources and political stability are the most influential variables. A skilled local workforce drives productivity and innovation, while political stability ensures a safe and predictable environment for investors. Moreover, the investment climate, tax incentives, and well-developed infrastructure are key enablers that reduce barriers and costs for investors. Statistical evidence from Tables 1 to 5 supports these conclusions, showing strong correlations and significant effects through both partial and simultaneous testing.

The research highlights that accelerating hydropower investment requires a comprehensive, multi-sectoral strategy. Regional governments must strengthen infrastructure, build human capital, ensure political and legal stability, and foster a transparent and supportive investment environment. By doing so, North Tapanuli can unlock its renewable energy potential and drive long-term, inclusive economic growth.

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