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Analysis Of The Determinants Of Electrical Energy Consumption In The Period Of 2017 – 2023 (Case Study Of Provinces In Indonesia)

Siti Naeni Nur Khaeni [*1]
Hastarini Dwi Atmanti [2]

[1,2] Economy Study Program, Faculty of Economics and Business, Diponegoro University
*e-mail:naeni.nurkhaeni@gmail.com[1], hastarinidwiatmanti@live.undip.ac.id[2]

Abstract

The purpose of this study is to examine the variables influencing Indonesia's electrical energy consumption from 2017 to 2023. Utilising secondary data from Central Bureau of Statistics of Indonesia and State Electricity Company (PLN) for the years 2017– 2023, quantitative research using a regression analysis approach is the study methodology employed. The population, income per capita, information technology development index, and human development index are the independent variables in this study. The population, human development index, and per capita income all had a significant impact on the amount of electrical energy used, according to the findings. In the meanwhile, there is a slight but negative impact from the information technology development index. Together, the independent factors can account for 88.6% of the fluctuation in Indonesia's electrical energy usage. According to the study's findings, increasing electrical energy.

Keywords*: HDI, ICT-DI, Income, Population*

INTRODUCTION

Energy is the backbone of economic development and social welfare, and plays a vital role in supporting economic activities and meeting people's consumption needs. Indonesia, as the country with the 12th largest electricity consumption in the world, is highly dependent on energy to support various sectors, such as job creation, agriculture, transportation, and trade. However, renewable energy consumption is also closely related to a country's economic activities, so an unbalanced increase in energy consumption can hurt economic productivity.

Energy storage is a significant element in the management of energy resources that have great potential to drive a country's economic growth (Shinta Devy et al., 2019). Its role is very important to support the achievement of national development goals, which require government regulations to ensure their availability, quality, and sustainability. In addition, energy storage has an important value in human life, with its urgency continuing to increase along with the development of science, technology, and the needs of modern society. Strategic energy management not only supports daily needs but also plays a key role in sustainably achieving national development goals (Ansari, 2017).

Electrical energy resources are vital to society because they supply electricity for a variety of domestic and commercial operations. Energy still does not provide much advantage in some parts of Indonesia, nevertheless. Seventy-three percent of the total energy supply is distributed in the Northeast region (NTT). According to (Nepal & Paija, 2019), this energy is crucial for day-to-day living and is prevalent in some areas, including the economy and industry. The Indonesian government uses PT. PLN (Persero) to oversee the country's energy supply in compliance with the 1945 Declaration of Human Rights The government is responsible for managing energy since it is seen as a primary resource.

According to (Wiryawan et al., 2016) electrical energy has a very important role in everyday life, used in various areas such as homes, offices, and factories. This widespread use is driven by global population growth and the development of the industrial revolution. In the modern era, four main groups of electricity users, namely households, industry, business, and the public sector, are highly dependent on electrical energy to carry out their activities. The use of electrical energy not only supports basic needs but is also a key factor in the globalisation process (Darmayanti, 2018) in (Akhrani, 2024). Electrical energy supports various aspects of human life,

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from business, and industry, to daily household needs (Rosadi & Amar B, 2019). In addition, electrical energy is very much needed for various purposes, such as lighting, entertainment, transportation, and production, including the operation of electronic equipment and industrial machinery (Nilman & Mintargo, 2019). This confirms that electricity is the main component that drives the modernisation and sustainability of human life.

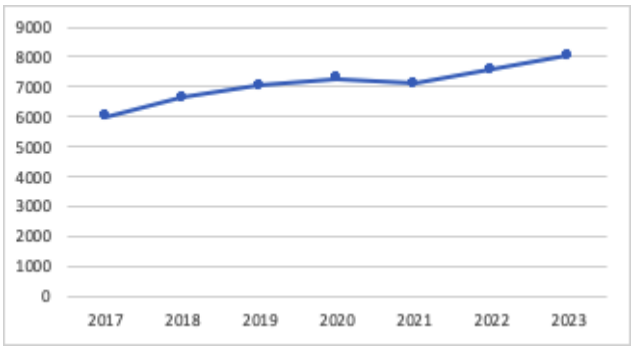

Figure 1 Percentage of Electricity Consumption in Indonesia 2017 – 2023 (GWh)
Source: State Electricity Company (PLN).

Based on Figure 1, electricity consumption in Indonesia has increased by an average of 6% per year in the period 2017 to 2023. This growth is mainly influenced by the government's steps to increase electricity tariffs and expand renewable energy capacity in various regions in Indonesia. However, other factors that influenced the increase in electricity consumption during this period, such as changes in electricity usage patterns, infrastructure development, and economic growth, still require deeper analysis to understand the dynamics and impacts as a whole.

More efficient spending management allows people to buy essential devices such as computers, televisions, and other needs that support government and business operations. This condition can encourage increased spending on essential goods and services, which in turn facilitates business operations and helps reduce production costs. In addition, with increased public spending, economic activities will be stimulated, creating a domino effect in the form of increased consumption and more sustainable economic growth.

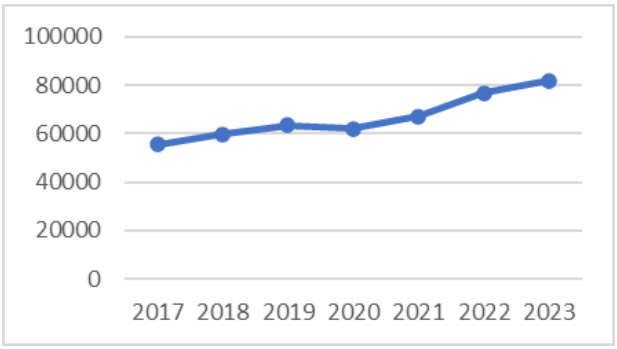

Figure 2 Percentage of Income per capita in Indonesia 2017 – 2023 (rupiah)
Source: Central Bureau of Statistics of Indonesia

Based on Figure 2, Indonesia's GDP per capita has increased over time, especially in 2019, 2020, and 2023, according to BPS data. Although the COVID-19 pandemic caused a decline in economic growth in 2020, the overall growth rate showed a stable upward trend from 2017 to 2023, despite the impact of the pandemic on the economy.

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Research by (Rosadi & Amar B, 2019) shows that certain factors significantly influence customer behaviour, which can increase satisfaction levels and the likelihood of more customers making purchases. With more rewards to meet their needs without worrying about price, individuals who have higher rewards tend not only to remain loyal but are also more likely to make repeat purchases.

Population is an important factor influencing electricity consumption. The more people in an area, the need for housing and food increases, which in turn will increase people's spending. This increase in spending contributes to economic growth. In addition, a large population also drives the need for industry and trade to meet people's needs. Therefore, projects that support population growth must be implemented to ensure that electricity consumption needs are met properly.

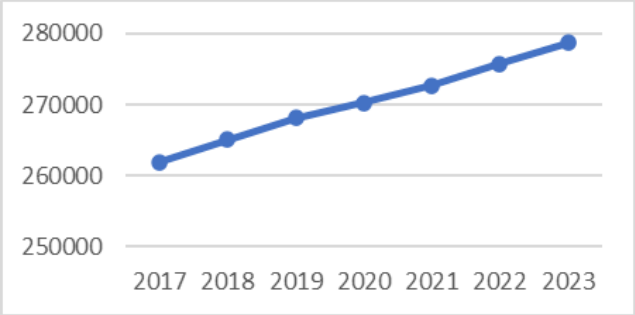

Figure 3. Percentage of Population in Indonesia 2017 – 2023 (people)
Source: Central Bureau of Statistics of Indonesia

Based on Figure 3, Indonesia's population continues to increase every year from 2017 to 2023. In 2017, the population was recorded at 262.3 million people, which then increased to 272.2 million people in 2022. It is estimated that this number will reach 274.2 million people in 2023, according to BPS data. However, it should be noted that the COVID-19 pandemic has caused a decrease in the population during this period.

The Information and Communication Technology (ICT) Development Index plays an important role in influencing consumer behaviour. The increasing use of digital devices, such as smartphones, laptops, and tablets, has a direct impact on household consumption. In addition, the ICT Development Index contributes to the digitalisation of the industrial and transportation sectors, which in turn reduces the need for servers, data centres, and telecommunications infrastructure, thus affecting commercial consumption.

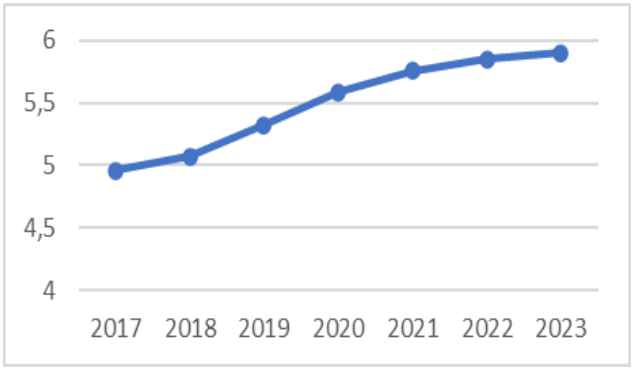

Figure 4. Percentage of Information and Communication Technology Development Index 2017 – 2023 (percent)
Source: Central Bureau of Statistics of Indonesia

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Based on Figure 4, in 2017, Indonesia's ICT Development Index reached 4.96, indicating a significant increase in education development. This figure continued to increase to 5.07 in 2018 and reached 5.32 in 2019, thanks to the 3G/4G network and increased internet usage. The COVID-19 pandemic further pushed this index up to 5.59 in 2020, and in 2021, the index increased again to 5.79. Projections for 2022 show a figure of 5.85, but it is estimated to decrease to 3.90 in 2023. This indicates the need for further improvement in the quality of education in Indonesia.

Countries with a high HDI typically have better infrastructure, including a more reliable electricity grid. Better access to electricity allows people to take advantage of various tools and technologies that increase efficiency and productivity, although it may also increase electricity consumption. The Human Development Index (HDI), which is a logarithmic function of the increase in energy and electricity consumption, helps determine low and high levels of population productivity (Lefaan & Dalimi, 2018). HDI affects electricity consumption in Indonesia through mechanisms such as higher per capita including electricity. Communities with a high HDI tend to feel worthy of using energy facilities to support a modern lifestyle.

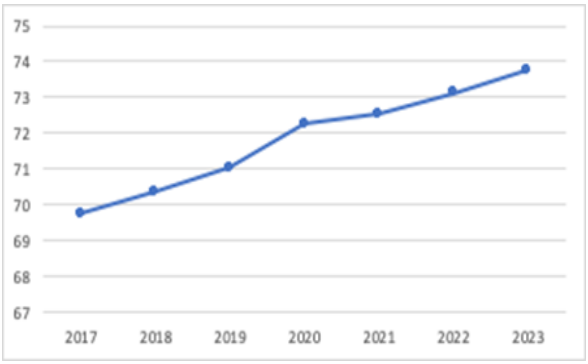

Figure 5. Percentage of Human Development Index 2017 – 2023 (percent)
Source: Central Bureau of Statistics of Indonesia

Based on Figure 5, in 2017, Indonesia's Human Development Index (HDI) was ranked 69.75 and increased to 70.39 per cent in 2018. In 2019, this figure increased again to 71.04 per cent, and after the Covid-19 pandemic, the HDI reached 72.25 per cent in 2021. In 2022, the HDI increased again to 73.12 per cent and is estimated to reach 73.77 per cent in 2023. This increase indicates steady progress in health and education during the 2017-2023 period. Thus, Indonesia's HDI aims to improve the overall quality of life.

Consumption is the part of a society's budget that is used to purchase goods necessary for daily activities. People's consumption patterns are influenced by a number of variables, including prices, interest rates, population, wealth, and income (Hanum et al., 2017). According to (Mankiw & Sungkono, 2018) consumption is a term used to describe household spending on either goods or services. Expenditures on old goods and intangible goods, such as food and clothing, fall into the "goods" category. The consumption function shows the relationship between the level of disposable personal income and consumption expenditure. According to Keynes' consumption theory, the level of income available for consumption affects current consumption and disposable income (Nuryati, 2022). So according to Keynes, current consumption is significantly affected by the level of available income, and that consumption growth is closely related to the level of available income (Mukrimaa et al., 2016) in (Akhrani, 2024).

This study aims to investigate the correlation between electricity consumption and per capita income, population, ICT development index, and human development index. Stable electricity consumption plays an important role in maintaining a region's economic output, while efficient electricity utilisation can drive overall economic growth. By understanding this

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relationship, it is hoped that better strategies can be found to improve energy efficiency and support economic development.

METHOD

This study uses secondary data obtained from companies, government agencies, and other related sources, including data from the Central Statistics Agency and the State Electricity Company. The collected data are then analysed quantitatively, which is considered more appropriate for statistical analysis. The two types of statistics used in this analysis are descriptive and inferential statistics. Descriptive analysis is presented with the help of tables and graphs, while inferential analysis will use a panel data regression model approach. In this study, Eviews 12 software is used to analyse data covering 34 provinces in Indonesia from 2017 to 2023. The purpose of this panel data regression model is to determine the relationship between population, per capita income, information and communication technology development index, and human development index as independent factors, and Indonesia's energy consumption as the dependent variable. The research method used is panel data regression with a model developed based on the following study:

$$KLit = \alpha + \beta 1 LnPPit + \beta 2 LnJPit + \beta 3 LnIPTIKit + \beta 4 LnIPMit + Uit \ldots\ldots (1)$$

Where

α	: Constant
$\beta 1, \beta 2, \beta 3, \beta 4$	: Regression Coefficient
$KLit$	: Electricity Consumption
$PPit$	: Per capita income
$JPit$	: Population
$IPTIKit$	: Information and communication technology development index
$IPMit$	: Human development index
Uit	: Error component
i	: District (cross-section)
t	: Period

RESULTS AND DISCUSSION

Development of information and communication technology and the human development index for 2017- 2023 in Central Java Province with 34 provinces.

Table 1. Descriptive Statistics Results

	N	Minimum	Maximum	Mean
Per capita income	238	180.5900	56226.11	7099.835
Population	238	17165.00	322615.0	66700.26
Information and communication technology development index	238	691.1000	49860.30	7950.996
Human development index	238	3.220000	8.270000	5.588950
Electricity consumption	238	59.09000	83.55000	71.83790

Source: Secondary Data (2024)

The results in Table 1 show that the electricity consumption variable obtained an average value (mean) of 71.83790. The per capita income variable obtained an average value (mean) of

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7099.835. The population variable obtained an average value (mean) of 66700.26. The technology and information development index variable obtained an average value (mean) of 7950.996. The human development index variable obtained an average value (mean) of 5.588950.

Table 2. Regression Estimation Results

	Coefficient	Std.Error	t-statistic	Prob
Income per capita	0.341497	0.071166	4.798607	0.0000
Total population	0.149806	0.067331	2.224927	0.0270
Information and communication technology development index	0.227947	0.054927	4.150020	0.0000
Human development index	0.168892	0.071549	2.360514	0.0191

Source: Secondary Data (2024)

$$Y = \beta_0 + 0.341497X_1 + 0.149806X_2 + 0.227947X_3 + 0.168892X_4 + \varepsilon$$

The findings of Table 2 show that there is a relationship between the variables of income per capita and electricity consumption. Specifically, an increase of 1 income per capita will increase electricity consumption by 0.341497. Electricity consumption is influenced by the population variable, an increase of 1 in the population will result in an increase of 0.149806 in electricity consumption. Electricity consumption is influenced by the variable of the information and communication technology development index for example, an increase of 1 in population density will result in an increase of 0.227947 in electricity consumption . Electricity consumption is influenced by the HDI variable. For example, if the HDI increases by 1, then electricity consumption will increase by 0.168892.

Table 3. Results of The Normality Test

Kolmogorov-Smirnov Z	0,659
Asymp. Sig. (2-tailed)	0,778

Source: Secondary Data (2024)

The results of the normality test in Table 3, at a significance level of 0.778 > 0.05, indicate that the data does not follow a normal distribution.

Table 4. Heteroscedasticity Test Results

Heteroskedasticity Test: ARCH			
F-statistic	1.797211	Prob. F(1,235)	0.1813
Obs*R-squared	1.798750	Prob. Chi-Square(4)	0.1799

Source: Secondary Data (2024)

The Chi-Square Prob. Value of Obs*R-squared = 0.1799 > 0.05 indicates that the assumption of homoscedasticity is met, by the results of the heteroscedasticity test in Table 4. In other words, the residuals do not show any signs of heteroscedasticity.

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Table 5. Multicollinearity Test Results

	Coefficient variance	Uncentered VIF	Centered VIF
Income per capita	0.005065	7.664563	5.074043
Total population	0.004533	6.877300	4.005969
Information and communication technology development index	0.003017	4.716068	3.091920
Human development index	0.005119	8.957206	5.386094
Coefficient	0.001456	1.778401	NA

Source: Secondary Data (2024)

Considering that the centered VIF value in the multicollinearity test results in Table 5 is less than 10, it can be said that there are no signs of multicollinearity among the independent variables.

Table 6. Autocorrelation Test Results

Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	1.128378	Prob. F(2,231)	0.3253
Obs*R-squared	2.302647	Prob. Chi-Square(2)	0.3162

Source: Secondary Data (2024)

The findings of the autocorrelation test in Table 7 show that the assumption of autocorrelation is met if the value of the Chi-Square Prob. of Obs*R-squared = 0.3162 > 0.05. In other words, the residuals do not show any symptoms of autocorrelation.

Table 7. Model Feasibility Test Results (f)

F-statistic	169.51
Prob (F-statistic)	0.0000

Source: Secondary Data (2024)

Based on the results of the feasibility test shown in Table 8 above, Ho is rejected with an f-statistic value of 169.51 and an f-statistic probability of 0.00000 <α 5%. Electricity consumption is the dependent variable, and the independent variables of per capita income, population, technology and information development index, and human development index have a significant influence on these variables.

Table 8. Results of The Determination Coefficient Test

R-squared	0.774
Adjusted R-squared	0.739

Source: Secondary Data (2024)

The R-square coefficient, or R R2, for the feasibility test results in Table 9 is 0.774. This indicates that the independent variables-per capita income, population, information and communication technology development index, and human development index-are able to

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explain 77.4% of the variance of the dependent variable, namely electricity consumption. Meanwhile, factors not included in the model explain the remaining 22.6%.

Table 9. Hypothesis Test Results (t)

	Coefficient	Prob
Income per capita	0.341497	0.0000
Total population	0.149806	0.0000
Information and communication technology development index	0.227947	0.0270
Human development index	0.168892	0.0000

Source: Secondary Data (2024)

The results of the hypothesis test in Table 10 show the t-test that the first hypothesis study discusses the relationship between per capita income and electricity consumption. The probability value is 0.000 <α (prob. = 0.000 <0.05), and the regression coefficient is 0.341497. The first hypothesis (H1) is accepted because the statistical test shows that per capita income has a significant effect on electricity consumption. The results of the study show the second hypothesis about the relationship between population and electricity consumption. The results show that fertiliser subsidies have a probability of 0.000 <α (prob. = 0.000 <0.05), and the regression coefficient is 0.148806.

The second hypothesis (H2) in this study is accepted because the results of the statistical test show that population has a significant impact on electricity consumption. The test results show that the information and communication technology index has a relationship with electricity consumption with a probability of 0.0270 <α (prob. = 0.0270 <0.05), and has a regression coefficient of 0.227947. This is the third hypothesis.

The third hypothesis (H3) in this study is rejected because the results of the statistical test show that the information and communication technology development index has a significant effect on electricity consumption. The results of the study show that the economic development index has a significant effect on electricity consumption, with a probability value of 0.000 <α (prob. = 0.000 <0.05). Thus, the regression coefficient is 0.168892.

Thus, the fourth hypothesis (H4) is accepted. The per capita income variable has a significant effect on electricity consumption so this first hypothesis is accepted. The results of this study are in line with (Rezki, 2012) stating that an increase in state or individual income will cause an increase in their demand for certain goods, so that there is an elastic relationship between the level of per capita income and the level of electricity consumption. In other words, electricity demand will increase along with income, which in turn will lead to increased electricity consumption. However, the increase in electricity prices will have an impact on society as a whole, resulting in a decrease in the need for electricity. The population variable has a significant effect on electricity consumption so the second hypothesis is accepted. Given that electricity is very important for the needs of society, electricity consumption will increase along with population growth.

The electrification ratio in each province in Indonesia is very different. In line with research (Thuku et al., 2013) with an increasing population, a country will have the capacity to produce more goods and services, which in turn will increase the consumption of these goods and services. The information and communication technology development index variable has a significant effect on electricity consumption so the third hypothesis is rejected. In line with research (Sadorsky, 2012) the influence of greater use of information technology on energy shows that, although the movement of the economy towards greater use of information technology can cause overall energy demand to decrease, increased use of information technology increases energy consumption. The human development index variable has a significant effect on electricity consumption so the third hypothesis is accepted. In line with research (Suprapto & Hasanah,

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2022) increasing community access to electricity is one of the efforts to increase the HDI. The quality of human development is improved by the availability of electricity, both in terms of education, health, and purchasing power.

CONCLUSION

Several conclusions can be drawn from the results of data processing for 2017-2023 obtained using the panel data analysis method, the results of data analysis and statistical testing, and the discussion that has been described. The conclusions include the following: per capita income is correlated with electricity consumption, population is correlated with electricity consumption, and this study provides theoretical and practical implications. Population, per capita income, information and communication technology development index, and human development index are all studied experimentally in this study.

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