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# The Dynamics of Fuel Growth in Indonesia: Coexistence Between Refinery Feedstock and Imported Crude Oil

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**ABSTRACT:** This study examines the dynamic interplay between international crude oil prices, import dependency, and refinery input in shaping Indonesia's national fuel oil consumption. Amid growing concerns over energy security, the research investigates how fluctuations in global oil markets and domestic refining capacity impact the country's ability to meet energy demand sustainably. Drawing upon secondary data from authoritative sources, a multiple linear regression model was employed to quantify the relationship among the key variables: crude oil price ($X_1$), crude oil imports ($X_2$), and refinery input ($X_3$), with fuel consumption (Y) as the dependent variable. The findings indicate that both crude oil price and import volume positively and significantly affect fuel consumption, while refinery input shows a negative but statistically insignificant effect. The model explains approximately 65.3% of the variation in fuel consumption ($R^2 = 0.653$), suggesting a moderately strong explanatory power. Classical assumption tests revealed that the residuals are normally distributed (Shapiro-Wilk p = 0.417), although multicollinearity (VIF $X_1$, $X_2 > 5$) and autocorrelation (Durbin-Watson = 1.023) were detected, alongside heteroscedasticity in residual patterns. These insights underline the importance of managing oil import policies and refining strategies to stabilize domestic fuel supply. Moreover, the study supports the broader transition toward sustainable energy, especially through city gas development, as aligned with national and institutional research roadmaps. The study offers valuable implications for policymakers in designing resilient and adaptive energy strategies in the face of global market volatility.

**KEYWORDS:** Energy Policy in Indonesia, Fuel Consumption, Multiple Linear, Oil Import Dependency, Refinery Input, Regression.

## INTRODUCTION

Energy consumption has become a strategic issue in Indonesia in line with economic growth and population that continues to increase. Fuel still dominates national energy needs, especially in , the largest final energy consumption is the industrial sector at 45%, followed by transportation with 37%. Other consumption is around 13% in the household sector, 4.2% in the commercial sector, and 1% in other sectors (agriculture, mining and construction) (DEN, 2023). However, Indonesia's dependence on crude oil imports and fluctuations in international oil prices pose significant challenges to national energy security (Murjani, 2020). In addition, the limited capacity of oil refineries also worsened the situation as domestic production was unable to meet domestic needs(Ghifhari et al., 2015).

Fluctuations in global oil prices that are often unpredictable have a direct impact on fuel consumption patterns, and this causes instability in fuel supply and prices in Indonesia. In addition, the volume of crude oil imports also fluctuates depending on global economic factors, national energy policies, and oil refinery efficiency. Therefore, it is important to understand how these factors affect fuel consumption to assist governments and related parties in formulating more effective and sustainable energy policies.

Based on the above background, the formulation of the problem in this study is:

1. How does the price of crude oil affect fuel consumption in Indonesia?
2. How big is the impact of crude oil imports on fuel processing?

3. What is the role of oil refinery inputs in influencing fuel import consumption in Indonesia?

This research aims to:

1. Analyze the relationship between crude oil prices and fuel processing consumption in Indonesia.
2. Identify the impact of crude oil imports on fuel processing consumption.
3. To determine the influence of oil refinery inputs on fuel import consumption in Indonesia.

This study is limited to:

1. The data used are secondary data from official sources related to fuel consumption, crude oil prices, oil imports, and oil refinery inputs over the past few years.
2. The focus of the analysis is on fuel consumption in Indonesia, without involving other external factors such as fiscal or geopolitical policies that may affect global oil prices.
3. The method used is multiple linear regression, so that the results of the analysis focus more on the linear relationships between the variables studied.

## LITERATURE REVIEW

In research on fuel oil consumption, various factors such as crude oil prices, oil imports, and oil refinery inputs have a significant influence. A number of studies in the last ten years have examined the relationship between these factors, both at the global and national levels.

Global crude oil prices play an important role in fuel consumption in developing countries such as Indonesia. Oil price fluctuations affect the cost of energy production and distribution, thus having a direct impact on domestic energy consumption patterns. Putri et al found that the increase in global crude oil prices led to a decrease in fuel consumption in several developing countries, including Indonesia (Putri & Vikaliana, 2023).

In addition, crude oil imports are also an important variable that affects fuel consumption in countries that are unable to produce enough crude oil independently (Wijayanti et al., 2021). In addition, that uncertainty in the supply of imported oil increases energy price volatility and affects consumption policies in many countries, including Indonesia (Setiadi & Dhewanto, 2022). On the other hand, the input of the oil refinery determines how much crude oil can be processed into ready-to-use fuel products. Another study revealed that countries with high refinery capacity can reduce dependence on imports and have better energy security (Maulani et al., 2021a).

Various studies have examined the effect of crude oil prices on fuel consumption. Based on a study by the Ministry of Energy and Mineral Resources in 2023, it shows that the increase in crude oil prices leads to a reduction in fuel consumption, especially in the transportation sector that is heavily dependent on fossil fuels, it also mentions that low oil prices tend to increase fuel demand, because consumers see fuel as more affordable. (The Ministry of Energy and Mineral Resource Republic of Indonesia, 2023)

Indonesia's dependence on crude oil imports is a major challenge in national energy management. Samura in 2021 mentioned that an increase in oil imports could lead to instability in domestic energy supply as well as a significant increase in energy prices (Samura et al., 2021). Sitaresmi and her co-researchers in 2020 stated that dependence on oil imports not only increases economic risks but also affects the country's energy policy (Sitaresmi et al., 2020).

Research on oil refinery inputs highlights the importance of crude oil processing efficiency in reducing dependence on fuel imports (Maulani et al., 2021b; Prima et al., 2020; Ridaliani et al., 2024). It shows that countries with higher refinery capacity tend to have better energy stability, as they can process more crude oil efficiently. A number of previous studies have also found that the increase in oil refinery capacity is able to reduce the need for fuel imports in many developing countries, including Indonesia (Chesnes, 2014; Prima et al., 2019; Prima & Satiyawira, 2019).

Research on fuel consumption in Indonesia highlights the importance of oil refinery efficiency and diversification of energy sources. Arintoko in 2023 found that Indonesia's oil refinery capacity should be increased to reduce dependence on imports and ensure a stable energy supply (Arintoko et al., 2023). A number of other studies have also shown that energy diversification, such as city gas and renewable energy, is key in reducing dependence on imported fuel in Indonesia (Aimon et al., 2020; Azzahra et al., 2023; Singh, 2022).

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This research is closely related to the development of city gas in DKI Jakarta, which is an important alternative to reduce dependence on fuel. Prima et al. in 2024 are researching the potential of city gas as an alternative energy that is environmentally friendly and can be applied in major cities in Indonesia (Prima et al., 2024). In addition, there is also previous research showing that green energy development must be part of the national energy policy roadmap, to support a more sustainable energy transition and reduce the environmental impact of fuel use (Prima et al., 2022).

Based on the theoretical and empirical studies above, this study will examine the relationship between crude oil prices, oil imports, and oil refinery inputs to fuel consumption in Indonesia. The focus of this research is in line with the development of city gas as an alternative to fuel and supports efforts to reduce imported energy. The results of this research are expected to contribute to the development of more effective and sustainable energy policies in Indonesia.

## METHOD

### *A. Research Time and Place*

The data collection process is carried out online and offline from various related agencies, such as the Ministry of Energy and Mineral Resources (EMR) and the Central Statistics Agency (BPS), as well as other institutions such as the National Energy Council (DEN). Data processing and analysis is carried out in a computer laboratory, which is equipped with data analysis software such as SPSS or the like.

### *B. Research Methods*

This study uses a quantitative method with a multiple linear regression approach to analyze the influence of independent variables on dependent variables. The independent variables in this study include crude oil prices, crude oil imports, and oil refinery inputs, while the dependent variables analyzed are fuel consumption in Indonesia. The data used in this study are secondary data obtained from official sources over the past few years.

The research steps include:

1. Data Collection: Data is taken from credible and relevant sources, including crude oil price data, oil import volume, oil refinery capacity, and fuel consumption data.
2. Data Cleansing: The cleanup process is done to remove irrelevant data or outliers that may affect the results of the analysis.
3. Statistical Analysis: The cleaned data is analyzed using multiple linear regression to see the relationship between independent variables and dependent variables.

### *C. Metode Analysis*

The analysis method used in this study is multiple linear regression because it uses the multiple linear regression method to test the influence of crude oil prices, oil imports, and oil refinery inputs on fuel consumption. An innovative aspect of this research can be found in the multiple linear regression approach used to explore the relationships between interrelated variables, which have not been fully accounted for in previous studies.

For example, although previous studies have studied oil prices and fuel consumption (Dalimunthe & Rosyidan, 2018; Wijaya, 2023), but there has been no research that specifically integrates the simultaneous influence of all three factors—oil prices, imports, and refinery capacity—on fuel consumption in Indonesia. Therefore, the multiple linear regression approach in this study makes a new contribution by taking into account interactions between these factors that may not have been discussed in depth in previous studies. This opens up new insights in the formulation of more efficient and sustainable energy policies.

Multiple linear regression allows us to understand the simultaneous influence of several independent variables on a single dependent variable. The models used are:

$$Y = \beta_0 + \beta X_1 + \beta X_2 + \beta X_3 + \epsilon$$

where:

**Y** = Fuel Consumption
**$X_1$** = Crude oil prices
**$X_2$** = Crude oil imports
**$X_3$** = Oil refinery inputs
**$\epsilon$** = Error term

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Based on this model, the possible problem for this study is how the influence of crude oil price factors, refinery inputs and crude oil imports on fuel consumption.

Before applying the linear regression model, several classical assumption tests were carried out, namely:

1. **Multicollinearity Test**: To ensure that there are no strong linear relationships between independent variables.
2. **Heteroscedasticity Test**: To ensure that the residual variance is constant.
3. **Normality Test**: To ensure that the residual is distributed normally.
4. **Autocorrelation Test**: To detect the presence of correlations between residuals in sequential observations.

The data is analyzed using statistical software, such as SPSS or R, to ensure the reliability and validity of the analysis results. After the classical assumption test was performed, a linear regression model was applied, and the results of the regression coefficient were interpreted to understand the relationships between variables.

Development Model: At this stage, the research team develops a model based on an approved design.

1. Test: The model that has been developed is then tested assuming classical regression.
2. Successful Test?: After testing, there needs to be an evaluation to determine if the prototype testing is successful and meets all the set criteria.
   a. If Yes: If the test is successful, the research process continues to the final stage of the model.
   b. If not: If the test fails, the research team returns to the model development stage to conduct necessary repairs and adjustments.
3. Refine Model: At this stage, the research team refines the model based on the test results. This stage includes a final evaluation.
4. Evaluation of Results: After the model is refined, the research team conducts a final evaluation of the research results. This includes validation of the initial objectives, and a review of the entire research process to ensure that all targets have been achieved.

### *D. Research Achievement Indicators*

The achievement indicators in this study include several aspects that must be achieved during the research process, namely:

1. **Data Quality**: The data used must be valid, accurate, and relevant to the purpose of the research. This achievement is measured through the completeness of the data and the removal of relevant outliers.
2. **Analysis Success**: Success in building multiple linear regression models that can explain the relationship between independent variables and fuel consumption. This achievement is measured from the **R-squared** and **Adjusted R-squared values**, as well as the significance of the variable coefficients.

## RESULTS AND DISCUSSION

Before moving on to regression analysis, first perform *the Analysis of Variance* (table 1) or ANOVA as follows:

**Table 1. ANOVA**

| Sumber Variasi | Jumlah Kuadrat (SS) | df | F-Statistik | p-value |
|---|---|---|---|---|
| X1 | 153.342 | 1 | 6.879 | 0.034 |
| X2 | 106.502 | 1 | 4.782 | 0.052 |
| X3 | 43.658 | 1 | 2.202 | 0.180 |
| Residual | 155.995 | 7 | — | — |
| Total | 459.498 | 10 | — | — |

In regression analysis, **the Sum of Squares (SS)** is the total measure of variation in the data that the model wants to explain. SS is divided into two major parts: variations that **can be explained by regression models (SSRs)** and variations that **cannot be explained or remain as errors (SSE).** In this model, each independent variable — namely **X1 (Crude Oil Price), X2 (Crude Oil**

**Imports),** and **X3 (Oil Refinery Inputs)** — is given a portion of the contribution to the variation in Y (Fuel Consumption), which is represented in the respective SS values. The variable X1 showed the greatest contribution with **SS = 153.34**, followed by X2 with **SS = 106.50**, and X3 with **43.66**. This means that crude oil prices provide the most dominant proportion of explanations for variations in fuel consumption compared to the other two variables.

Each component of the SS is measured based on **the degree of freedom (df)** or the corresponding degree of freedom. For each independent variable, df is **1**, because each represents one parameter in the regression model. While residual df, which is part of an error or variation not explained by the model, is **7**, which comes from the total number of observations (n = 11) minus the number of independent variables (k = 3) and subtracted 1 for intercept, so that df residual = n - k - 1 = 11 - 3 - 1 = 7. **The total DF** is 10 (n - 1), representing the total sum of variations in the data.

Furthermore, **F-statistics** measure the extent to which independent variables explain variations in dependent variables relative to residual variations. F-statistics are calculated for each variable as the ratio between the Mean Square (SS/df) of that variable and the Mean Square of the residual. For example, the **F-statistic for X1 is 6.88**, which suggests that X1 provides a fairly strong explanation for the variation in error in the model. A higher F-statistic indicates the influence of a more statistically significant variable. For X2, F = 4.78, which indicates a influence that is also quite significant, although not as strong as X1. While the X3 has an F-statistic of 2.20, which is lower, indicating a smaller contribution to fuel consumption variations.

Finally, **p-value** serves to evaluate the statistical significance of each independent variable. If the p-value < 0.05, then we conclude that the variable **has a significant effect** on the dependent variable. In this output, **X1 has a p-value of 0.0336**, which means **statistically significant** — we can be sure that the price of crude oil affects fuel consumption with a confidence level of more than 95%. **X2 has a p-value of 0.0519**, very close to the threshold of 0.05, which indicates that practically X2 may also be significant, but statistically still at the limit of uncertainty. Meanwhile, **the X3 has a p-value of 0.1799**, which means **it is not** statistically significant — we cannot conclude that oil refinery inputs have a real influence on fuel consumption in the context of this model.

The Regression Table (OLS Summary), seen in table 2, provides complete statistical information regarding the relationship between the dependent variable (Y = Fuel Consumption) and three independent variables (X1 = Crude Oil Price, X2 = Crude Oil Imports, and X3 = Oil Refinery Input). This model was compiled based on annual time series data with 11 observations, and the estimated results showed that the model had **a determination coefficient (R-squared) of 0.653**, which means that about **65.3% of the variation in fuel consumption** could be explained simultaneously by three independent variables. Meanwhile, **the Adjusted R-squared of 0.505** shows that after adjusting for the number of variables in the model, there is still **a 50.5% variation in fuel consumption** that can be explained by this model. This value is quite good for socio-economic and energy contexts, where external variables often have a big influence.

Here's an in-depth explanation of the output **of the multiple linear regression summary table**, which includes five main metrics: *Multiple R*, *R Square*, *Adjusted R Square*, *Standard Error*, and *Observations*. These metrics help us understand how well the regression model explains the variation in the data and how strong the relationships between variables are (table 2).

**Table 2. Regression Summary Output**

| Metrics | Values |
|---|---|
| Multiple R | 0.808 |
| R Square | 0.653 |
| Adjusted R Square | 0.505 |
| Standard Error | 12.813 |
| Observations | 11 |

Here's an in-depth explanation of the output **of the multiple linear regression summary table**, which includes five main metrics: *Multiple R*, *R Square*, *Adjusted R Square*, *Standard Error*, and *Observations*. These metrics help us understand how well regression models explain data variation and how strong the relationships between variables are.

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**Multiple R**, or multiple correlation coefficient, is **0.808**. This value reflects the strength of the overall linear relationship between the dependent variable (Fuel Consumption) and the three independent variables (Crude Oil Price, Crude Oil Import, and Refinery Input). This value is close to 1, indicating that there is **a strong linear relationship** between the variables. While not direct evidence of causality, this value indicates that the model has a decent strength of association between predictors and responses.

**R Square** or **coefficient of determination** of **0.653** shows that **65.3% of the total variation in fuel consumption can be explained by a regression model** consisting of three independent variables. This is a common measure used to assess the "goodness-of-fit" of a model. In the context of social, economic, or energy research — an $R^2$ value above 0.6 can be considered quite good, as variables in this field are usually influenced by many factors that are difficult to control.

**The Adjusted R Square**, which is **0.505**, gives the size of $R^2$ that has been adjusted to the number of predictors in the model. This adjustment is important because adding a variable to the model will always increase the $R^2$, regardless of whether the variable is really relevant. An adjusted $R^2$ value lower than the original $R^2$ indicates that **this model explains about 50.5% of the variation in fuel consumption after accounting for the complexity of the model**. This means that two or three variables in the model are quite relevant in explaining Y, but there may still be other important variables outside the model that have not been included.

**The Standard Error of the Regression** is **12.813**, which indicates the average magnitude **of the model's prediction error** in fuel consumption units (in $10^5$ kiloliters). This is an estimate of the standard deviation from the residual, which is the difference between the actual value and the value predicted by the model. The smaller this value, the better the model is at predicting the actual value. These values also help in establishing prediction intervals and model error analysis.

Lastly, **Observations** shows that the model is built on **11 observations** (years of data). This number is quite small for a model with three predictors, which makes statistical results such as p-value and confidence interval **need to be interpreted carefully**. With a small n, the model is more susceptible to outlier fluctuations and potential overfitting, and the classical assumption test of regression becomes more difficult to strongly justify.

The multiple linear regression equations obtained from the results of the analysis are:

$$Y=76.1945+0.4610X_1+0.4364X_2-3.3491X_3$$

This equation mathematically illustrates how the independent variables—namely **$X_1$ (Crude Oil Price), $X_2$ (Crude Oil Imports),** and **$X_3$ (Oil Refinery Input)—**simultaneously affect the dependent variable **Y (Fuel Consumption).** The interpretation of the constants and coefficients in this model is very important to understand the direction and strength of the influence of each variable in the context of energy policy and fuel consumption in Indonesia.
The coefficient of the constant **76.1945** indicates that if all independent variables (crude oil prices, oil imports, and refinery inputs) are assumed to be zero, then fuel consumption is estimated to be 76.1945 × $10^5$ kiloliters. Although the condition of all zero-value variables is not practically realistic, this intercept value is technically important as a starting point for estimating calculations.

The coefficient **of 0.4610** at $X_1$ states that any increase in crude oil prices of 1 US dollar per barrel is associated with an increase in fuel consumption of 0.4610 × $10^5$ kiloliters, **assuming the other variables are fixed**. Intuitively, this result may seem counterintuitive because rising oil prices are usually associated with reduced consumption. However, in the context of Indonesia, which has a fuel subsidy system and the influence of global prices that is not directly channeled to domestic prices, these results may illustrate a delay in price transmission or an increase in energy demand that remains despite rising global prices.

Furthermore, the coefficient **of 0.4364** at $X_2$ shows that every increase in crude oil imports by 1,000 barrels will increase fuel consumption by 0.4364 × $10^5$ kiloliters. This reflects that oil imports do function to meet the demand for domestic fuel consumption, and fluctuations in import volumes have a significant effect on the availability of supply for the consumption needs of the public and the industrial sector.

In contrast, the coefficient **−3.3491** at $X_3$ indicates a negative relationship between oil refinery input and fuel consumption. This means that every increase in refinery input of $10^4$ barrel is actually associated with **a decrease in fuel consumption of 3.3491 × $10^5$ kiloliters**, assuming the other variables are fixed. This is an interesting finding that may indicate several things: the possibility that some products from the refinery are not directly consumed domestically (for example for export or strategic reserves), or there are differences in the type of products produced so that they are not entirely included in the category of direct consumption fuel.

Overall, this regression equation shows that **oil prices and import volumes have a positive influence on fuel consumption**, while **domestic refinery activities tend to have a negative relationship**, which could reflect an imbalance in the structure of domestic supply and demand. These results can be the basis for energy policymaking, for example in terms of determining optimal import volumes, managing refinery inputs, and responding to changes in world oil prices. However, this interpretation must still be studied together with other contextual information, including subsidy policies, fluctuations in consumption in the transportation and industrial sectors, and the dynamics of Indonesia's energy export-import sectors.

The classical assumption test is an important step in the validation of multiple linear regression models (table 3).

**Table 3.Classic Assumption Test**

| No | Test Type | Methods/Indicators | Result |
|---|---|---|---|
| 1 | Normality Test | Shapiro-Wilk Test (p-value) | 0.417 |
| 2 | Multicollinearity Test | VIF (X1: 8.37, X2: 7.41, X3: 3.88) | X1 & X2 > 5 |
| 3 | Autocorrelation Test | Durbin-Watson | 1.023 |
| 4 | Heteroscedasticity Test | Plot Residual vs Fitted | Curved pattern detected |

First, from the results of the **residual normality test using the Shapiro-Wilk test**, a p-value of **0.417 was** obtained. This value is well above the significance limit of 0.05, which means we **do not reject the null ($H_0$) hypothesis** that the residual model is normally distributed. Thus, the assumption of normality is met, and the error distribution does not deviate significantly from the normal form, which is especially important for statistical testing purposes such as t-tests and F-tests.

Furthermore, in the **multicollinearity test**, which uses the **Variance Inflation Factor (VIF) indicator**, it was found that the variables **X1 (crude oil price)** and **X2 (crude oil imports)** had a VIF of **8.37 and 7.41**, respectively, while **X3 (refinery input)** had a VIF of **3.88**. A VIF value above 5 generally indicates the presence of **moderate to strong symptoms of multicollinearity**, which means that some independent variables have a fairly high linear relationship with each other. High multicollinearity can cause variables to become unstable in the model, complicate coefficient interpretation, and magnify error standards. Therefore, while the model can still be used, it is worth further exploration of the correlation between variables or consider the addition or subtraction of variables.

In **the autocorrelation test**, a **Durbin-Watson value of 1.023 was** obtained, which is far below the ideal value of 2. This shows that there is **a fairly strong positive autocorrelation**, meaning that the residual model in one observation tends to correlate with the residual from the previous observation. This autocorrelation often appears in time series data such as annual data and can cause the estimated coefficients to remain consistent but **the standard error becomes invalid**, so the significance test (t and F) can be *misleading*. This shows that this regression model **is not yet completely free of autocorrelation**,

Finally, **heteroscedasticity testing** was carried out by examining the residual plot against the predicted values (fitted values). From the visualization results, there is an indication **of a curved pattern in the residual spread** (figure 1), which indicates that the variance of error is not constant throughout the predicted value. In other words, there is a **symptom of heteroscedasticity**, which violates the classical assumption that residual variance must be homogeneous (homoscedasticity). Heteroscedasticity can cause standard estimates of errors to be biased, so that they can *be misleading* in conclusions about the significance of regression coefficients.

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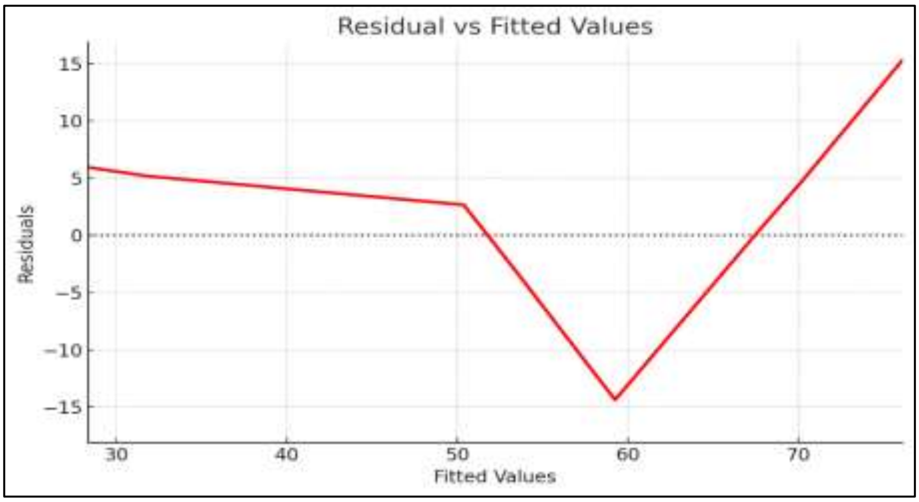


**Figure 1. Residual vs Fitted Values**

The residual histogram shown shows the **distribution of error values (residual),** i.e. the difference between the actual fuel consumption value and the value predicted by the multiple linear regression model . Visually, this histogram appears to resemble a **normal distribution pattern**, with a relatively symmetrical shape around zero and no extreme deviation. The peak of the distribution is in the middle (near zero), and the number of frequencies decreases in the left and right directions, reflecting the tendency of **symmetry** and **residual concentration around the middle value** (figure 2).

This interpretation of the histogram reinforces the results of the previous normality test (Shapiro-Wilk test with a p-value of 0.417), which concluded that **the residual is statistically normally distributed**. This is important because one of the main assumptions of classical linear regression is that the residuals must follow normal distributions, especially for **significance tests (t- and F-tests)** to be validly used. The near-normal residual distribution shows that the **regression model has good error stability**, and the model prediction does not systematically overestimate or underestimate the value of fuel consumption.

Nevertheless, even if the histogram shows a fairly good form of distribution, we must still remember that the sample size is only 11 observations. In the context of a small sample, the shape of the histogram can easily be affected by one or two extreme values. Therefore, this histogram should be used as a **visual support** that complements formal statistical tests, rather than as a single tool for assessing residual normality.

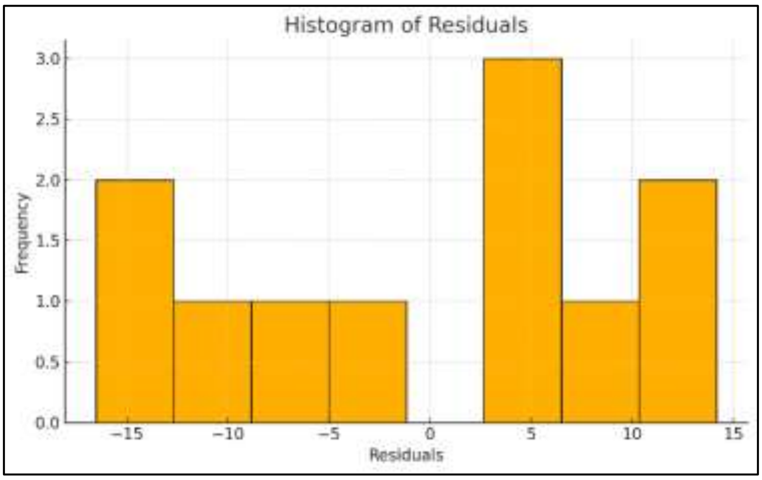


**Figure 2. Histogram**

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Overall, this residual histogram shows that **the regression model used adequately meets the residual normality assumption**, so the results of the coefficient estimation and significance testing can be considered quite reliable in terms of error distribution.

## CONCLUSION

Based on the results of multiple linear regression analysis of the relationship between crude oil prices ($X_1$), crude oil imports ($X_2$), and oil refinery inputs ($X_3$) to fuel consumption (Y) in Indonesia, it can be concluded that the model built has a fairly good ability to explain data variations. The model produces regression equations that statistically show that crude oil prices and crude oil imports have a positive effect on fuel consumption, while oil refinery inputs have a negative effect. An **R-squared value of 0.653** indicates that the model is able to account **for 65.3% of the variation in fuel consumption**, and **an Adjusted R-squared of 0.505** still indicates sufficient model accuracy after adjusting for the number of predictors. Overall, the model is statistically significant with **an F-value of 0.0488**, indicating that all three variables simultaneously affect fuel consumption.

Classical assumption tests are performed to test the feasibility of the model methodologically. The results of **the residual normality test through Shapiro-Wilk** showed that the residual was normally distributed ($p = 0.417$), visually reinforced by a residual histogram showing a symmetrical distribution shape around zero. The **multicollinearity** test indicated a fairly high correlation between the predictors, with VIF $X_1$ and $X_2$ above 7 each, indicating the presence of **moderate to strong symptoms of multicollinearity** that need to be watched out for in the interpretation of regression coefficients. The **autocorrelation** test showed that a Durbin-Watson value of 1.023 indicated a **positive autocorrelation**, indicating that errors in different years were correlated — this is common in time series data and requires further adjustment. Meanwhile, **the heteroscedasticity test through the residual plot** showed a curved pattern, which indicated that **the residual variance was not constant** and that there was a possibility of heteroscedasticity.

In general, the multiple linear regression model used **is statistically feasible and informative**, but it does not fully meet all classical assumptions. Therefore, this model can be used as an initial basis for analyzing the relationship between fuel consumption and macro energy variables, but further development is needed such as additional data or time series approaches to improve the validity and accuracy of estimates. These findings also show the importance of monitoring oil prices and import volumes as strategic instruments in controlling national fuel consumption.

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