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Chi-Square and 2-Way ANOVA for Accounting Students: Analysis of Natural Gas Sales Volume by Pipeline by Customer Type in Indonesia

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ABSTRACT

This study aims to analyze the sales volume of natural gas through pipelines based on the type of customer in Indonesia. This research combines two different fields of study, namely accounting and statistical analysis. This research in its early stages will explain the chi-square and 2-way ANOVA analysis according to the data presented. Based on the analysis that has been done, it can be concluded that there are differences in the volume levels of sales of natural gas through pipelines according to the type of customer (household, commercial, industry, power plants, and SPBE/SPBG) and there are not too many differences between the volume levels of natural gas sales through pipelines annually (2010-2017). Based on the findings of this study, it is suggested that the government and gas companies focus on developing pipeline infrastructure to support the growth of the industrial and commercial sectors.

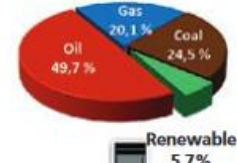**Keywords:** Chi-Square, 2-Way ANOVA, Natural Gas, Sales, Customer Type

INTRODUCTION

Natural gas is a fossil fuel in the form of gas. It is extracted from oil, natural gas, and coal mines. In Indonesia, the utilization of natural gas began in the 1960s when PT Stanvac Indonesia transported natural gas from their field in Pendopo, South Sumatra to PT Pupuk Sriwidjaja's fertilizer plant in Palembang through a gas pipeline. The adoption of natural gas usage in Indonesia has experienced significant growth since 1974. PT Pertamina (Persero) initiated the supply of natural gas via pipelines from the Prabumulih field in South Sumatra to Pusri II, III, and IV fertilizer plants in Palembang. The utilization of natural gas has expanded to other regions across Indonesia. Indonesia possesses substantial potential for developing natural gas, surpassing its petroleum reserves. The amount of natural gas that could be extracted from the archipelago in 2006 was 2.269 trillion British thermal units (tbtu). Part of the natural gas is used to meet the domestic demand of 843 tbtu (37%). Meanwhile, the remaining 1,426 tbtu (63%) was exported in the form of LNG or gas through pipelines. Natural gas reserves are estimated to be sufficient to be used for approximately the next 60 years. Currently, natural gas development projects that continue to be supported by the Government include Natuna D Alpha, which has a potential of around 46 trillion cubic feet (tcf); Tough Train 3 8.09 tcf; Donggi Senoro 2.8 tcf; and Masela 9.18 tcf.
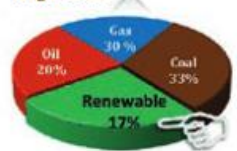
Kondisi Energi Indonesia

Kebijakan Energi Nasional

Kondisi saat ini

[Pie chart: Gas 20,1%, Coal 24,5%, Oil 49,7%, Renewable 5,7%]

Target 2025

[Pie chart: Gas 30%, Coal 33%, Oil 20%, Renewable 17%]

1. **28% atau Rp. 428 triliun** penerimaan negara (2012), berasal dari sektor ESDM.

2. **BBM dan listrik masih disubsidi (Rp. 225 T tahun 2012) dan 77%** tidak tetap sasaran;

3. **Investasi sektor ESDM mencapai US$ 27 miliar (2011),** iklim investasi cukup kondusif.

4. **Indonesia memiliki keanekaragaman energi.** Ketergantungan energi fosil masih tinggi, padahal cadangannya terbatas

5. **Minyak porsi terbesar dalam bauran energi (49,7%).**

   Pemanfaatan EBT masih sekitar 6%. **EBT ditargetkan akan mencapai 17% pada tahun 2025;**

6. **Pemanfaatan gas bumi nasional yaitu 56% untuk ekspor** dan **44% untuk domestik**

7. **Keterbatasan infrastruktur merupakan tantangan** dalam pemenuhan energi domestik.

8. Akses energi masih terbatas, **rasio elektrifikasi sebesar 73%**

Figure 1. Indonesia's Energy Condition

Source: Directorate General of Oil and Gas, Ministry of Energy and Mineral Resources

It is absolutely necessary to change the composition of energy sources considering that currently, Indonesia's status has changed from a net oil exporter to a net oil importer country. A paradigm shift (Junaedi et al., 2023) from oil to gas domination with diminishing sources and production of petroleum and the discovery of large reserves of natural gas.
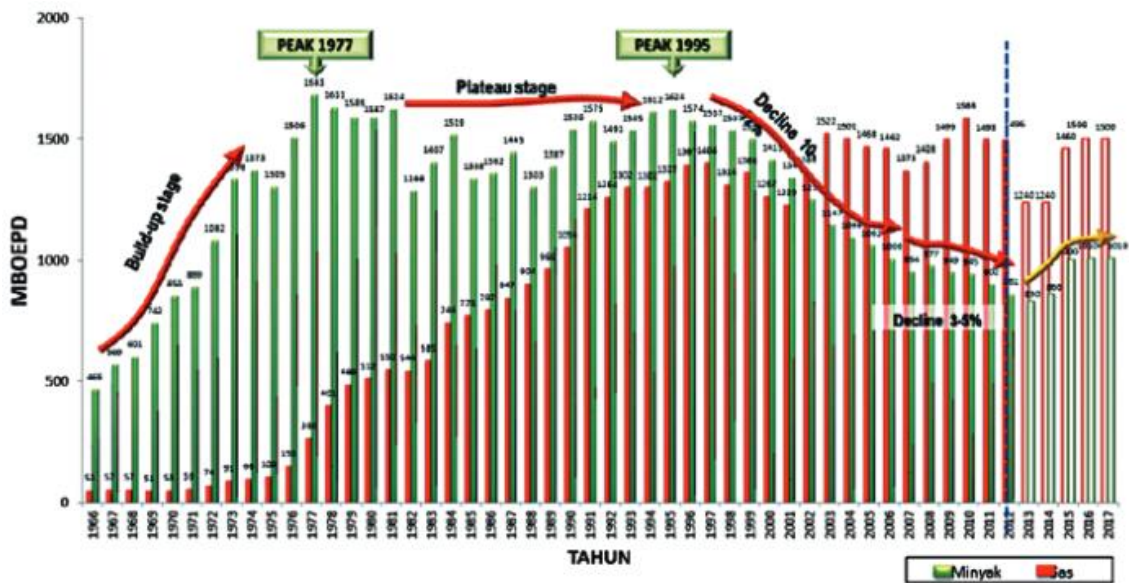

Figure 2. Oil Fluctuation

Source: Directorate General of Oil and Gas, Ministry of Energy and Mineral Resources

From this graph it can be seen that the volume level of sales of natural gas (pipe) in Indonesia from highest to lowest each year is 1) Industry 2) Power Plants 3) Commercial 4) SPBE/SPBG 5) Households. Meanwhile, the level of sales volume of natural gas (pipe) in Indonesia every year from 2010 – 2014 tends to increase steadily and from 2015 – 2017 decreases but there is no difference in volume that is too much from the previous year.

Students majoring in accounting have difficulties studying statistical material. One of them is the chi-square test and 2-way ANOVA. This study aims to analyze the sales volume of natural gas through pipelines based on the type of customer in Indonesia as well as provide insight to accounting students on how to calculate, analyze, and interpret data processing results. This research combines two different fields of study, namely accounting and statistical analysis. In this context, the motivation of the research is to show how statistical methods such as Chi-Square and 2-Way ANOVA can be applied in the analysis of accounting data to generate deeper insights.

LITERATURE REVIEW

Statistics

Statistics is a scientific discipline that involves the gathering, examination, understanding, and communication of data. In statistics, data is used to draw conclusions or make generalizations about the population or phenomenon being observed. Statistics includes a variety of methods and techniques for organizing, summarizing, describing, analyzing, and presenting data. The main purpose of statistics is to provide an objective framework for inferring reliable information from available data (College, 2013; Howell, 2014; Kokoska, 2015).

Statistics can be used in a variety of fields, including social sciences, natural sciences, health, economics, business, marketing, and more. Some basic concepts in statistics include data measurement, data distribution, probability, regression analysis, hypothesis testing, and analysis of variance. Statistics have an important role in decision-making (Renaldo et al., 2022; Suhardjo, Renaldo, Suyono, et al., 2022) based on data. By using statistical methods, we can identify patterns, trends, relationships, and significant differences in data, which can be used to support better and more accurate informed decision-making (Chandra et al., 2018).

In practice, statistics involves the use of statistical software, computation, sampling techniques, research design, and data processing to produce results that are reliable and can be used for evidence-based decision-making.

Chi-Square

The chi-square test is a statistical method utilized to compare observed and expected data. Its purpose is to determine whether any differences between the actual and predicted results are due to random chance or if there is a relationship between the variables being studied. This test is particularly useful for examining and interpreting the association between two categorical variables (Lind et al., 2018; Wu & Deng, 2012).

To evaluate a hypothesis about the distribution of a categorical variable, it is necessary to use a chi-square test or a similar nonparametric test. Categorical variables, which represent categories like animals or countries, can be classified as nominal or ordinal. These variables cannot follow a normal distribution because they can only take on a limited set of specific values.

2 Way ANOVA

2-Way ANOVA, also called Two-Way ANOVA, is a statistical method used to analyze the effect of two different factors (in statistics, factors often refer to the independent variable) on a dependent variable (response variable). In 2-way ANOVA, data is collected from each combination of factors observed. There are two factors that affect the response variable, and each factor has two or more levels or groups. This method allows us to understand whether the two factors significantly influence the response variable, as well as the interactions between the two factors (Arendacká, 2012; LaMotte, 2017; Mathew et al., 2010; Rao et al., 2022; Wang & Sun, 2013; G. Zhang et al., 2021; J. T. Zhang, 2012).

The 2-way ANOVA analysis procedure involves calculating the squared axes (sum of squares) for each factor and interaction, as well as the degrees of freedom and F values to test the statistical significance of these effects. If there are significant differences between the groups formed by these factors, it can be concluded that these factors influence the response variable. In conclusion, 2-way ANOVA allows us to understand the effects of two different factors and their interactions on the response variable. This method is especially useful in research or experimental contexts where there are two factors to be investigated simultaneously.

METHODOLOGY

Research Design

This research in its early stages will explain the chi-square and 2-way ANOVA analysis according to the data presented (Sekaran & Bougie, 2016). This study uses quantitative analysis.

Data Sources and Types

Data sources on coffee exports are obtained from the Central Bureau of Statistics. The type of data is secondary data because it is obtained through a second party and has undergone data processing before.

Data Analysis Techniques

The Chi-square and 2-way ANOVA method based on (Lind et al., 2018) starts with hypothesis testing. The stages of testing the hypothesis are as follows:

1. Mention the Null Hypothesis (H0) and Alternative Hypothesis (H1)

NULL HYPOTHESIS is a statement about population parameter values developed for the purpose of testing numerical evidence. AN ALTERNATE HYPOTHESIS is a statement that is accepted if the sample data provides sufficient evidence that the null hypothesis is false

2. Select a Significance Level

LEVEL OF SIGNIFICANCE is the probability of rejecting the null hypothesis when it is true. TYPE I ERROR Rejects the null hypothesis, H0 when it is true. TYPE II ERROR Does not reject the null hypothesis when it is false.

3. Select Test Statistics

TEST STATISTICS is a value, determined from sample information, used to determine whether to reject the null hypothesis.

4. Formulate Decision Rules

CRITICAL VALUE is the dividing point between the region where the null hypothesis is rejected and the region where it is not rejected.

5. Make a decision

6. Interpret Results

RESULTS AND DISCUSSION

Chi-Square Test

The study created a contingency table to find out whether or not there was a relationship between the volume level of sales of natural gas through pipelines each year and the type of customer. Using the chi-square test with df = 24, α = 5%, we get 36.415. By calculating the results of X^2 = 17,545.996, it can be concluded that the results are significant (there is a relationship between the volume level of sales of natural gas through pipelines each year and the type of customer).

2-Way ANOVA test

The 2-way ANOVA test is as follows:

Table 1. 2-Way ANOVA Calculation

Category	Sales Volume of Natural Gas Through Pipelines by Type of Customer							TOTAL
	2010	2011	2012	2013	2014	2015	2017	
Household	641.94	635.24	618.05	596.34	611.82	714.91	696.91	4,515.21
Commercial	5,067.32	7,028.82	7,570.18	6,851.29	7,472.94	8,131.57	6,732.44	48,854.56
Industry	196,356.46	227,759.28	272,832.32	295,618.59	337,106.04	314,646.22	329,086.27	1,973,405.18
Power plants	9,872.29	10,295.15	18,715.84	14,831.76	18,475.89	35,332.88	15,168.65	122,692.46
SPBE/SPBG	1,036.79	1,005.26	819.75	1,237.47	2,388.25	2,359.36	777.43	9,624.31
TOTAL	212,974.80	246,723.75	300,556.14	319,135.45	366,054.94	361,184.94	352,461.70	2,159,091.72

Source: Processed data, 2023

The F Two Way ANOVA test is used to determine whether there are differences in the volume of sales of natural gas through pipelines each year and differences in sales of natural gas through pipelines according to the type of customer. Using α = 5%, treatment = 2.50819 (df1=6, df2=24); blocks = 2.77629 (df1=4, df2=24). Through calculations obtained F Count (Treatment) = 1.2919 and F Count (Block) = 195.1045. So, it can be concluded that there are differences in the sales of natural gas through pipelines according to the type of customer and there is no difference in volume of sales of natural gas through pipelines each year.

CONCLUSION

Conclusion

Based on the analysis that has been done, it can be concluded that there are differences in the volume levels of sales of natural gas through pipelines according to the type of customer (household, commercial, industry, power plants, and SPBE/SPBG) and there are not too many differences between the volume levels of natural gas sales through pipelines annually (2010-2017).

Recommendation

Based on the findings of this study, it is suggested that the government and gas companies focus on developing pipeline infrastructure to support the growth of the industrial and commercial sectors. In addition, efforts should also be made to promote the use of natural gas in households, so as to increase the contribution of domestic customers to natural gas sales.

Recommendations for future research are to apply chi-square and 2-way ANOVA in the research topics of firm value (Renaldo, Andi, et al., 2021), stock prices (Renaldo, Suhardjo, et al., 2021; Suyono et al., 2022), supply chain management (Renaldo & Augustine, 2022), environmental performance (Sudarno et al., 2022), earnings management (Renaldo & Murwaningsari, 2023; Suhardjo, Renaldo, Andi, et al., 2022), and other research topics.

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