First Ciera Publisher

Improving Accounting Students' Statistical Understanding of 2-Way ANOVA Through a Case Study of Indonesian Coffee Exports

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ABSTRACT

The phenomenon that exists in this study is the lack of understanding of accounting students in understanding analysis of variance or better known as ANOVA, especially 2-way ANOVA. This study uses the case of Indonesian coffee exports. This research in its early stages will explain the 2-way ANOVA analysis according to the data presented. Then in the second stage will explain students' understanding of the 2-way ANOVA method. The level of understanding of accounting students regarding the 2-Way ANOVA method is still low. This is caused by factors of education level, curriculum, and experience. Significant 2-way ANOVA test results can open up opportunities for in-depth follow-up research. For example, a more detailed analysis of the significant factors and exploration of more complex interactions between the variables involved can be carried out.

Keywords: Accounting, Statistical, 2-Way ANOVA, Coffee, Exports

INTRODUCTION

Economic development in Indonesia is very much discussed, one sector that is rarely discussed is the Indonesian coffee export sector. Indonesia is one of the world's largest coffee exporters. Through coffee, the Indonesian economy reaps significant benefits. Indonesian coffee production as a whole is 630 thousand tons per year, of which 430-450 thousand tons are for export and 160-170 thousand for domestic consumption.

Based on BPS data, national coffee exports in 2017 grew 12.56% to 464 thousand tons compared to 2016. Total coffee exports per year are worth USD 1.2 billion or the equivalent of Rp. 16.8 trillion (referring to the exchange rate of Rp. 14,000/USD).

The following is coffee export data by the main destination country for 2010-2017.

Table 1. Coffee Exports by Main Destination Countries, 2010-2017

Destination Country	2010	2011	2012	2013	2014	2015	2016	2017
Neto (Ton)								
Japan	59.170,9	58.878,9	51.438,4	41.920,4	41.234,3	41.240,1	35.351,9	29.503,0
Singapore	6.079,0	6.240,4	9.154,1	8.677,9	7.725,9	9.212,9	7.099,1	7.178,0
Malaysia	26.200,1	26.382,1	33.134,1	40.580,4	29.136,2	38.347,5	39.049,0	41.394,1
India	9.733,3	12.162,4	19.884,0	18.292,4	14.434,3	19.303,0	11.574,0	8.291,0
Egypt	12.024,7	10.013,9	17.594,6	17.538,3	15.694,6	20.854,2	21.142,7	24.039,6
Morocco	8.369,1	10.013,0	11.268,6	12.874,3	10.418,7	11.069,1	9.720,5	11.072,4
Algeria	10.303,2	7.298,4	10.488,9	24.265,5	10.590,6	16.911,6	9.885,0	19.022,9
United States	63.048,0	48.094,7	69.651,6	66.138,1	58.308,5	65.481,3	67.309,2	63.237,6
Total	**194.928,3**	**179.083,8**	**222.614,3**	**230.287,3**	**187.543,1**	**222.419,7**	**201.131,4**	**203.738,6**
FOB Value (Thousand US$)								
Japan	118.889,8	174.712,2	145.733,9	102.909,0	101.350,4	104.952,8	86.504,5	82.361,7
Singapore	9.568,3	15.055,7	32.310,4	22.408,4	21.326,9	30.037,0	15.929,9	18.778,1
Malaysia	36.797,8	56.404,2	67.125,5	73.818,8	54.574,3	67.202,7	67.352,4	82.054,4
India	13.270,2	21.298,0	38.752,4	32.335,9	25.737,2	31.914,3	17.058,5	15.786,1
Egypt	19.009,3	24.035,4	38.090,8	35.572,7	32.396,4	39.537,6	41.171,2	52.796,2
Morocco	12.488,8	21.522,9	24.035,6	24.216,0	21.190,9	20.348,9	17.863,0	23.545,7

Destination Country	2010	2011	2012	2013	2014	2015	2016	2017
Algeria	15.390,5	13.285,4	21.970,4	43.622,1	20.949,1	30.145,2	17.353,2	38.629,1
United States	176.360,6	274.491,0	330.814,7	207.037,6	295.903,1	281.079,1	269.895,6	256.351,4
Total	**401.775,3**	**600.804,8**	**698.833,7**	**541.920,5**	**573.428,3**	**605.217,6**	**533.128,3**	**570.302,7**

Processed from customs documents of the Directorate General of Customs and Excise (PEB and PIB)
Quoted from the Indonesian Statistical Publication

Source: Central Bureau of Statistics, 2019

Based on the data above, the first table can be seen that how many tons of coffee per year Indonesia export to other countries, and the second table is an export table with FOB (Free on Broad), namely goods delivered or the obligation to pay shipping costs for goods to the nearest port of country of the purchaser (importer).

The phenomenon that exists in this study is the lack of understanding of accounting students in understanding analysis of variance or better known as ANOVA, especially 2-way ANOVA. From the results of the preliminary survey, students who did not understand at all reached 15% and students who partially understood reached 35%.

This study aims to improve the statistical understanding of accounting students while at the same time providing a deeper knowledge about Indonesian coffee exports through the 2-Way ANOVA analysis approach. This method can also be used to utilize available statistical methods so that it can make better coursework and scientific work assignments.

Statistics is one of the important components in the field of modern accounting. Accounting study program students need to have a strong understanding of statistics in order to be able to perform accurate data analysis and provide evidence-based recommendations. By increasing their understanding, students will have better analytical skills and be able to face complex challenges in accounting.

LITERATURE REVIEW

Statistics

Statistics is a science that deals with the collection, analysis, interpretation, and presentation 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, Jollyta, et al., 2022; Suhardjo, Renaldo, Suyono, et al., 2022) based on data. Using statistical methods, we can identify significant patterns, trends, relationships, and differences in data, which can be used to support better decision-making and more accurate information.

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.

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 2-way ANOVA analysis according to the data presented. Then the second stage will explain students' understanding of the 2-way ANOVA method (Sekaran & Bougie, 2016).

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 Technique

The 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. ALTERNATE HYPOTHESIS is a statement that is accepted if the sample data provide 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. α symbol

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

2-way ANOVA calculation

Two-way ANOVA testing will follow the stages of hypothesis testing:

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

   H_{0a}: There is no difference in coffee exports by the destination country

   H_{0b}: There is no difference in coffee exports by year

   H_{1a}: There are differences in coffee exports based on destination countries

   H_{1b}: There are differences in coffee exports by year

2. Select a Significance Level

   The significance levels used are 1%, 5%, and 10%, each of which will be represented with symbols ***, **, and * if necessary.

3. Select Test Statistics

   The test statistic used is 2-way ANOVA.

4. Formulate Decision Rules

The critical value based on the help of the F statistic table is 1.663730. For treatment and block the values are the same because there are 8 countries and 8 years.

Treatment df1 = k – 1

Block df1 = b – 1

Errors df2 = (k-1)(b-1)

5. Make a decision

To perform a 2-way ANOVA test, calculate the average vertically and horizontally

Coffee Export by Main Destination Country	2010-2017 Average (Tons)
Japan	1,993
Singapore	3,409
Malaysia	15,235
India	6,315
Egypt	7,717
Morocco	4,711
Algeria	6,043
United States	27,848

Coffee Exports by Year	Average (Tons)
2010	10,829
2011	9,949
2012	12,368
2013	12,794
2014	10,419
2015	12,357
2016	11,174
2017	11,319

Based on the table above, the average from 2010 to 2017 has increased quite significantly. The average export for 2011 decreased to 9,949.1 tons per year. The United States is the country with the largest coffee intake compared to the other countries in the table.

Based on these calculations, several components needed in the ANOVA test can be calculated.

SS BLOCK	6.845.332.067
SS TREATMENT	2.625.524.009
SS TOTAL	11.485.982.598
SS ERROR	2.015.126.522

SS Block is obtained from the sum of the squares of the difference in the average per line with the average of the entire data, in this case per destination country. SS Treatment is obtained from the sum of the squares of the difference in the average per column with the average of the entire data, in this case per year. Total SS is obtained from the sum of the squares of the difference between the data and the average of the entire data. While SS Error is obtained from SS Total – SS Treatment – SS Block.

From the data in the table obtained SS Block, SS Treatment, SS Total, and SS Error which can be seen in the table. The data is obtained by using the formula.

Source of Variation	SUM of Sources	df	Mean of Sources	F count	F table
Treatment	2.625.524.009	17	154.442.589	22,14943	1,663730
Block	6.845.332.067	17	402.666.592	57,74856	1,663730
Error	2.015.126.522	289	6.972.756		
Total	11.485.982.598	323			

6. Interpret Results

Then compare the F count and F table, and it is found that the F count from Treatment and Block is bigger or more significant than the F table. This means that there are differences in coffee exports between destination countries and there are differences in coffee exports between the years of the observation period. Then hypotheses H1a and H1b are both accepted.

Discussion

Significance of Influence Factors

In the significant 2-way ANOVA test results, it can be identified factors that have a significant influence on coffee exports. For example, factors such as coffee price, coffee quality, type of destination market, or trade policies can have a significant effect on Indonesia's coffee exports.

Interaction between Factors

Through the results of a significant 2-way ANOVA test, it can be observed the interaction between the factors that affect coffee exports. For example, does coffee price have a different effect depending on the destination market or does coffee quality affect coffee exports differently depending on the trade policies adopted?

Variability in Coffee Exports

Significant 2-way ANOVA test results can also provide information (Chandra et al., 2018; Renaldo, Suharti, et al., 2021; Sudarno et al., 2022) about variability in Indonesian coffee exports. For example, are there significant differences in export quantities between different destination markets or do changes in coffee prices have a significant effect on the variation in exports?

Student Understanding Level

From the results of observations, there are several factors that can affect the level of understanding of accounting students towards 2-Way ANOVA, including:

1. Education level: Undergraduate students who have completed a statistics or research methods course may have a better understanding of ANOVA, including 2-Way ANOVA, than students who have not completed the course.

2. Curriculum focus: If the accounting study program places more emphasis on aspects of financial or management accounting, understanding statistics may be less in-depth. This can have an impact on the level of student understanding regarding 2-Way ANOVA.

3. Prior experience: Students who have previous background or experience in statistics or research may have a better understanding of 2-Way ANOVA than those who do not have a similar experience.

CONCLUSION

Conclusion

Based on all the data above, it can be concluded that there has been an increase in Indonesian coffee exports from the previous year, and for the following year, there will be a significant increase. So, it is true that Indonesia is one of the largest coffee exporters in the world, and if the government empowers the people more, provides education, and so on, Indonesia can become number one in terms of coffee exporters beating Brazil which is currently in first place. The level of understanding of accounting students regarding the 2-Way ANOVA method is still low. This is caused by factors of education level, curriculum, and experience.

Implications

Significant 2-way ANOVA test results can have important implications for managerial decision-making and policy formulation in the Indonesian coffee industry. For example, these results can be used to identify key factors that need attention in efforts to increase coffee exports, optimize price settings, improve product quality, or adjust market strategies. The implication of increasing the understanding of accounting students is to organize a good education.

Recommendation

Significant 2-way ANOVA test results can open up opportunities for in-depth follow-up research. For example, a more detailed analysis of the significant factors and exploration of more complex interactions between the variables involved can be carried out. Then educational institutions to be able to make accounting students

more able to understand statistical material in an easy and fun way. Future research can also develop this 2-way ANOVA method for other examples of cases such as fraud detection (Renaldo, Sudarno, et al., 2021), forensic accounting (Renaldo, Sudarno, et al., 2022), stock price analysis (Suyono, Renaldo, Suhardjo, et al., 2022), bonus compensation (Suhardjo, Renaldo, Andi, et al., 2022), exchange rates (Firmansyah et al., 2022), SWOT analysis (Nyoto et al., 2023), action research class (Suyono, Renaldo, Andi, et al., 2022), and other forms of cases.

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