A Comparative Analysis of Total Production Cost Estimation via High-Low Point and Least Square Techniques in Tofu and Tempe Ayam Jago Factory, Banda Aceh

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Abstract: This research was conducted at the Jago Chicken Tofu and Tempeh Factory located in Banda Aceh, Aceh Province. This research aims to provide a comprehensive picture of the behavior of costs included in production costs. Separation of costs is carried out using the high-low point and least square methods. The production cost data used is data from March to May 2023. It is hoped that the results of this research can be used by the Banda Aceh Ayam Jago Tofu and Tempeh Factory in estimating more accurate production costs.

Key words: *Separation of costs, cost behavior, high-low point, least squares method.*

1.0 INTRODUCTION

The company that was founded has a goal, this goal can be carried out by the company to have a long term, even forever, by having good profits. A manufacturing company where the management pays great attention to every step they take, one of which is determining production costs. Production costs used by manufacturing companies are the results of the company processing raw materials into finished goods. These production costs can be classified based on cost behavior. Calculation of cost behavior by management will be able to determine the amount of costs that will be incurred for processing raw materials into finished goods.

Management also needs to calculate the estimated costs that will be incurred. The company's cost estimates for the next period will be the main thing that company management pays attention to. Cost behavior analysis can provide input for management in the process of estimating production costs. Cost behavior analysis can be used as a tool for management to predict the costs that the company will incur in the future. Separation of variable costs in determining cost behavior patterns, namely fixed costs and variable costs. Variable costs in a company determine the amount of production costs, while fixed costs are period costs, but in determining the separation of variable costs and fixed costs, you don't just have to guess, you have to use the high-low point method and the least squares method. The Rooster Tofu and Tempe Factory is in the process of production costs, including the costs of raw materials consisting of vinegar and soybeans used in producing tofu. Other production costs such as direct labor involved in processing raw materials into products. The Rooster Tofu and Tempe Factory has 2 direct workers who will be paid wages over some time. Apart from that, other production costs include factory overhead costs which must be paid for auxiliary materials such as tofu printing and knives. This business does not calculate production costs using the high-low point method and least square method, so the factory does not know the estimates for production units and production costs for the next month, namely June. The problem limitation in this final project is only to separate variable costs and fixed costs from estimating the total cost of tofu production using the high-low point method and least squares method at the Ayam Jago Tofu and Tempeh Factory in Banda Aceh. With relevant data taken for the period March-May 2023.

2.0 LITERATURE REVIEWS

Cost accounting

According to (Massie et al., 2018, p.356) cost accounting is the recording of a company's financial transactions over a certain period of time. Transaction which means an agreement between two parties where one party sells goods or services while the other party buys the goods or services. According to (Harahap, B., Tukino, 2020, p.1) cost accounting is the process of recording, classifying, reporting and interpreting costs related to the production of goods and services. Costs that occur in the company will produce cost information that management will use for decision making.

Understanding Costs

According to (Mulyadi, 2018, p.8) costs in a broad sense are sacrifices of economic resources measured in units of money that have occurred or are likely to occur for certain purposes. In a narrow sense, costs are an economic resource for obtaining basic prices. According to (Massie et al., 2018, p.356) costs are sacrifices to obtain assets, as used for economic sacrifices to produce goods or services, while expenses are sacrifices for processing to obtain income. All activities can be measured in units of money which are commonly called costs in the business world.

Cost Classification

According to (Hansen., & Mowen, 2019, p. 56) costs are grouped into 2 main functional groups, namely, non-production and production. Production costs are costs that are related to the process of forming the products and services provided, while non-production costs are costs that are not related to the process of forming the goods or services provided. According to (Mulyadi, 2016, p. 13) costs are classified into 5 groups:

1. According to Expenditure Object.
2. According to the main function of a company.
3. According to the relationship between costs and what is financed.
4. According to the behavior of costs with changes in the volume of activity.
5. According to time period.

Production Cost Concept

According to (Ramdhani et al., 2020, p. 21) production costs are one of the cost classifications in cost accounting based on management functions. Cost accounting is a branch of accounting which is a management tool for presenting cost information in the form of cost reports. This cost report is needed by management in managing the company which includes planning and controlling profits.

Understanding Production Costs

According to (Halim, 2019, p.4) production costs are expenses that have already occurred (expired) which are used in processing the products produced. That the ability and quality of the apparatus greatly influences asset management.

Elements of Production Cost

According to (Jannah, M., 2018, p.91) in the production process, manufacturing companies usually incur several expenses which are included in the costs. There are three costs in question, namely direct materials, direct labor and factory overhead.

1   Direct Material

Direct materials are all raw materials that form an integral part and the finished product is included explicitly in the product cost calculation.

2   Direct Labor

Direct labor is labor that processes raw materials directly into finished products and can be appropriately charged to certain products.

3   Overhead Costs

Overhead costs are all manufacturing costs that are not traced directly to a specific output. For example, indirect standard costs, indirect labor costs. In simple terms, costs other than direct raw materials and direct labor.

Cost Behavior

According to (Siregar et al., 2019, p.73) cost behavior is a pattern that describes how the amount of costs varies with changes in business activities. A company's business activity can be constant, increasing, or decreasing. However, some costs remain constant even though business activities change. There are three types of cost behavior:

1. Fixed Costs (fixed costs)

Overall costs do not change when business activity increases or decreases. The total fixed costs vary from one period to another. This difference is caused by changes in production volume within a certain cashier range.

2. Variable Costs (variable costs)

Costs in total change in proportion to changes in the volume of activity, but the cost per unit is relatively constant, not influenced by changes in activity. The higher the cost of the activity volume, the higher the total variable costs. and vice versa, the amount of variable costs is influenced by changes in production cost activities. Variable costs remain constant when expressed per unit.

3. Mixed Costs (mixed costs)

Mixed costs are costs that have the characteristics of both variable costs and fixed costs. Some of the mixed costs change with changes in production unit activity. Meanwhile, others have not changed even though the level of activity of the production unit has changed.

Benefits of Semi-Variable Cost Separation

According to (Zainuddin., Yustiana Djaelani, 2022, p.3) there are several benefits to separating semi-variable costs, namely:

1   Knowing the amount of fixed costs and variable costs incurred by the company in producing products for short-term decision making.

2 Can provide better information for cost control, especially semi-variable costs, where in determining production costs only include costs that are variable in nature so that it can increase the profit contribution to the company.

3 Can find out how much variable costs per unit and how much fixed costs.

Mixed Cost Segregation Techniques

According to (Siregar et al., 2019 p87) mixed costs include variable costs and also fixed costs, for good cost analysis and estimation. There are three methods used to separate variable costs and fixed costs in mixed costs, namely:

Graphic Method

One way to analyze costs is to graph them. Cost graphs reflect the distribution of costs for different levels of activity. A cost graph is drawn in which the horizontal axis shows activity levels and the vertical axis shows cost levels.

High-low Point Method

According to (Siregar et al., 2019, p.92) the highest and lowest point method is a method of estimating variable and fixed elements of mixed costs by identifying costs that change and costs that do not change with changes in production unit activity between the highest activity and the lowest activity.

$$\text{Variable Cost} = \frac{\text{Highest activity cost}(Y_2) - \text{Lowest activity cost }(Y_1)}{\text{Highest activity }(X_2) - \text{Lowest activity}(X_1)}$$

$$\text{variabel Cost} = \frac{\text{change in production costs}}{\text{change in production unit activity})} = \frac{Y_2 - Y_1}{X_2 - X_1}$$

Least Square Method

According to (Siregar et al., 2019, p.95) the least squares regression method is a method of estimating variable and fixed elements of mixed costs by regressing activities against the costs of those activities. This method assumes that the relationship between activities and costs is linear. Therefore, the regression used is linear regression. The regression equation in the least squares method is:

$$Y = a + bx$$

a = Constant (describes fixed costs)

b = Coefficient (describes variable costs)

Y = Mixed costs

x = Production unit activity

The following are the stages of analyzing variable and fixed elements of mixed costs using the least squares regression method

1   Compile production unit activity data and historical costs that occurred in various periods.

2   Determining variable costs. Variable costs (b) are calculated using the following formula:

$$b = \frac{(N \times \sum XY) - (\sum X \times \sum Y)}{\sum X 2 - (\sum x)2}$$

Determine fixed costs. Fixed costs (a) are calculated using the following formula:

$$a = \frac{\sum Y - b \sum X}{N}$$

N = Number of observations

According to (Qomaria, A, T, 2020, p.18) there are three methods for estimating production costs with a linear function as follows:

1. **High-low point method**

In this method, the fixed cost and variable cost elements are a cost calculated using two points. The point is selected from the highest and lowest point data. The difference between these two points is caused by changes in capacity and the size of the unit variable costs.

2. **Standby cost method**

This method calculates how much fixed costs will be incurred if the company is temporarily closed, so the product is equal to zero. These costs are called guard costs, these guard costs are included in fixed costs. The difference between the costs incurred during the production period and maintenance costs can be called variable costs.

3. **Least squares method**

The method for separating variable costs and fixed costs is by determining the relationship between the level of production unit activity and production costs, then simple regression by separating semi-variable costs into fixed cost and variable cost components using all the data. Formula

$$b = \frac{(N \times \sum XY) - (\sum X \times \sum Y)}{\sum X 2 - (\sum X)2}$$

$$a = \frac{\sum Y - b \sum X}{N}$$

Where:

a= fixed costs

b= variable cost per unit

n= number of data points

x= number of x values given

y= number of y values used

xy= the sum of the amounts obtained by multiplying each given x value by the y value

Based on the calculation of production costs, it can be expressed in the form of a linear function asas follows:

Y= a + bx

Where:

Y = Mixed costs

x = volume of production units

a = Fixed costs

b = Variable Costs

According to (Zainuddin., Yustiana Djaelani, 2022, p.3) the separation of semi-variable costs is as follows:

1   High and Low Methods

This method is a technique for separating variable costs by way to compare costs at the highest level of activity compared to those costs at the lowest level of activity in the past. The calculated cost difference is a variable cost element in these costs. Meanwhile, fixed costs reduce semi-variable costs with variable costs.

2   Least Square Method

This method assumes that the relationship between production costs and the volume of production unit activities is in the form of a straight line with the equation

Y = a + bx

Where:

Y = Mixed costs

a = Fixed costs

b = Variable costs

x = volume of activity (units)

3.0 METHODOLOGY

Data Sources and Data Collection Techniques

Data source

A data source is something that can provide information about a related researcher. The data used by this researcher uses two types of data sources, namely as follows:

1   Primary data

According to (Hamid, 2016) primary data is a data source that is directly related to research. The author collects data or information directly using in-depth interviews. Recording primary data sources through interviews and observations is the combined result of viewing, listening and asking questions.

2   Secondary data

According to (Hamid, 2016) secondary data is a source of information that does not directly provide information for data collection. For example, library research, whether from books, magazines, documents, notes and other written sources.

This final project uses primary data in the form of results from interviews at the Ayam Jago Tofu and Tempeh Factory in Banda Aceh.

Data collection technique

Data collection techniques are the methods used by writers to collect information about the final project. The information used to obtain this information is:

1. Observation

    (Ni'matuzahtoh., Prasetyaningrum, 2018, P.3) believes that the term observation comes from Latin which means seeing and paying attention. Observation aims at activities that pay attention to phenomena, accurately understand phenomena as they occur and consider the relationship between different aspects of the phenomenon. , and pay attention to events, symptoms, or problems in a focused manner.

2. Interview

    (Fadhallah, 2021, p.2) states that an interview is communication between two or more parties which can be carried out face to face, where one party acts as an interviewer. For example, another party acts as an interviewee for a certain matter. Target the information to obtain or collect data. The interviewer asks the interviewee several questions to get answers. The results of the interview provide information related to basic information or information obtained directly from the tofu and tempe factory for the preparation of the final project.

3. Literature review

    This researcher is intended by the author not only to obtain material from observations and interviews, but also to obtain information from books that support this final project.

Data Discussion Method

The data discussion method in this research discusses production costs. The steps that need to be taken in calculating total production costs using the high-low point method and least squares method at tofu and tempeh factories are as follows:

1. Conduct interviews to obtain transaction data information
2. Collect and compile data to group costs including raw material costs, direct labor costs, and factory overhead costs in producing tofu.
3. Calculating production costs using the high-low point method and least square method at the Banda Aceh Tofu and Tempe Factory.

4.0 Data Analysis and Findings

In this research the object is to calculate the total production costs at the Ayam Jago Banda Aceh tofu and tempeh factory, which operates in the manufacturing sector. Located on Jl. Fajar Harapan Ateuk Jawo, Banda Aceh City.

This tofu and tempeh factory is a research site to obtain various data about the costs and activities of production units related to the research title of this final project.

Findings

Production Cost

The production costs carried out in the tofu factory business consist of the costs of purchasing raw materials such as soybeans and vinegar, employee salary payments, electricity payments, water payments, purchasing machine oil and purchasing firewood. The object does not calculate production costs and production units using any method, so the calculation of production units and production costs can be seen in the following table:

Table 4.1 Number of Production Units and Total Production Costs for March – May 2023

Month	Total Production Costs	Production Quantity (units)
March	IDR. 104,132,700	180,000
April	IDR 97,903,400	155,000
May	IDR 99,452,000	165,000

Source: Processed data, 2023.

High-low Point Method

The high-low point method in this research discusses production costs and production units into the highest and lowest activity levels. The discussion carried out can use the data in Table 4.2 to see the highest and lowest points of production activities and product units to see total production costs.

Table 4.2 Production Costs and Production Units for March – May 2023

Month	Total Production Costs	Production Quantity (units)
March	Rp. 104,132,700	180,000
April	IDR 97,903,400	155,000
May	IDR 99,452,000	165,000

Source: Processed data, 2023

Based on Table 4.2, it can be seen that the highest production costs were in production in March 2023 and the lowest point was in production in April 2023. The highest production unit occurred in March 2023 and the lowest point was in April 2023.

The calculation of the highest and lowest points for calculating tofu production costs and tofu production units can be seen as follows:

$$\text{Variable Cost} = \frac{Highest\ activity\ cost(Y_2) - Lowest\ activity\ cost\ (Y_1)}{Highest\ activity\ (X_2) - \text{Lowest activity}(X_1)}$$

From the formula above, calculations can be made using variable costs as follows:

$$\text{Variable costs} = \frac{\text{Rp } 104.132.700 - \text{Rp } 97.903.400}{180.000 - 155.000}$$

$$= \frac{\text{Rp } 6.229.300}{25.000}$$

Variable costs = Rp 249,172 /unit

Based on variable cost calculations, IDR 249,172 / unit can be obtained

Fixed Cost

Fixed costs in this research depend on the costs incurred to produce for the running of the business. Because the highest production costs are in March 2023, the highest point calculation is carried out using data for March 2023 as follows:

Fixed costs = total costs – (variable costs x units of production)

=Rp104,132,700- (249,172 x 180,000)
=IDR 104,132,700 – 44,850,960
=IDR 59,281,740
Production costs based on fixed cost calculations in March were IDR 59,281,740.

The lowest production costs are in April 2023, so the calculation of the lowest point using data for April 2023 is as follows:

Fixed costs = total costs – (variable costs x units of production)

= Rp97,903,400– (249,172x 155,000)
=IDR 97,903,400– 38,621,660
= IDR 59,281,740
Production costs based on fixed cost calculations in April were IDR 59,281,740.

The results of the fixed cost calculation to calculate the highest and lowest points, it can be seen that the total fixed costs for the highest point were 59,281,740 and for the lowest point 59,281,740 for 2 months of producing tofu (March to April).

Calculation of Production Costs Using the High-low Point Method

Based on the results of calculations using variable costs and fixed costs, it can be expressed in a linear function as follows:

Y= a + bx
Y= IDR 59,281,740 + IDR 249,172 x

It can be analyzed that Y is the estimated production cost of tofu produced in a certain period and x is the tofu production unit in a certain period. This linear equation can be used to estimate tofu production costs for the next month, namely June. We can plan this estimate for production activities which are estimated to be 189,000 production units for tofu units, then production costs can be estimated using the following linear function equation:

Y = a + bx

Y = IDR 59,281,740 + IDR 249,172 x

Y= IDR 59,281,740 + IDR 249,172 (189,000)

Y= IDR 59,281,740 + 47,093,508

Y = IDR 106,375,246

Where:

Y = total production costs

a = Production costs (rupiah)

b = Unit cost (rupiah)

Based on these calculations, the estimated production costs for June 2023 are estimated to produce 189,000 units and are estimated to cost IDR 106,375,246. Separating semi-variable costs using the high-low point method only calculates the highest and lowest points for the period taken in this research in March 2023 and April 2023, where the costs are calculating the highest and lowest total production costs, calculating highest unit and lowest unit. Calculations that only look at two pairs of data, therefore do not reflect the semi-variable costs in the observed cost behavior.

Based on the results of calculating variable costs and fixed costs, they can be substituted as follows:

Highest point calculation with data in March 2023

March = total fixed costs + variable costs x number of production units

= IDR 59,281,740 + IDR 249,172 x 180,000

= IDR 104,132,700

This value corresponds to the total production costs for March, namely 104,132,700.

Calculation of the lowest point using data for April 2023

APR = total fixed costs + variable costs x number of production units

= IDR 59,281,740 + IDR 249,172 x 155,000

= IDR 97,903,400

This value corresponds to the total production costs for April 2023, namely 97,903,400.

4.2.1 Least Square Method

The least squares method in this research discusses production costs as seen through a set of data points.

Calculation of production costs using the least squares method can be seen in Table 4.3 as follows:

Table 4.3 Calculation of Production Costs and Production Units Based on the Least Square Method

Month	X (units)	Y (production cost)	X2	XY
March	180,000	IDR 104,132,700	IDR 32,400,000,000	IDR 18,743,886,000,000
April	155,000	IDR 97,903,400	IDR 24,025,000,000	IDR 15,175,027,000,000
May	165,000	IDR 99,452,000	IDR 27,225,000,000	Rp. 16,409,580,000,000

Source: Processed data, 2023

4.2.2 Variable Costs

In calculations using the least squares method, variable costs can be calculated as follows:

$$b = \frac{(N \times \sum XY) - (\sum X \times \sum Y)}{\sum X^2 - (\sum X)^2}$$

$$b = \frac{(3 \times \sum Rp50.328.493.000.000) - (\sum Rp500.000 \times \sum Rp301.488.100)}{Rp83.650.000.000 - (\sum Rp500.000)^2}$$

$$b = \frac{Rp\ 150.985.479.000.000 - 1Rp\ 50.744.050.000}{Rp83.650.000.000 - 500.000^2}$$

$$b = \frac{Rp\ 241.429.000.000}{Rp83.650.000.000 - 250.000.000.000}$$

$$b = \frac{Rp\ 241.429.000.000}{Rp83.650.000.000 - 250.000.000.000}$$

$$b = \frac{RP\ 241.429.000.000}{-Rp\ 166.350.000.000}$$

$$b = -Rp\ 1,451$$

Variable costs obtained –RP 1,451

Based on this formula, variable costs can be negative because from the calculation of the formula for the production costs listed, divided by production costs raised to the power, you get a negative result from the division using the variable formula for estimated production costs.

4.2.3 Fixed cost

In calculations using the least square method, fixed cost calculations can be carried out as follows:

$$a = \frac{\sum Y - b \sum X}{N}$$

$$a = \frac{\sum Rp301.488.100 - (-1,451) . \sum Rp500.000}{3} \quad a = \frac{Rp301.488.100 - (-725.665)}{3}$$

$$a = \frac{Rp.302.213.765}{3}$$

$$a = 100.797.921$$

So production costs using fixed cost calculations can be obtained at IDR 100,797,921.

4.2.4 Calculation of Production Costs Using the Least Square Method

To calculate fixed costs and variable costs in a linear equation like the following:

Y = a + bx

Y = +100.797.921 (−1,451) x

Estimate a to be the total fixed production costs, then the monthly fixed costs are Rp 100.797,921 The monthly variable costs per unit of production are – Rp 1,451,namely estimates for variable costs. Based on these results, it can be estimated that for the next month, namely June 2023, an estimate of 189,000 units of tofu production can be estimated using the following linear equation:

Y = a + bx

Y = Rp. 100,797,921 + (-Rp. 1,451) x

Y= IDR 100,797,921 + (-IDR 1,451) . 189,000

Y= IDR 100,797,921 + (-247,301)

Y= IDR 100,523,619

Based on these results, the estimated production costs for June 2023 are estimated to produce 189,000 units and the production costs are estimated to be IDR 100,523,619. The results of the linear equation using the least squares method can calculate all data points, so that you can simply measure the average change in subsequent variable costs by estimating the increase in units produced. This method can also be used as an estimate for the next month's production costs for June, which in this business is considered more accurate because it can be seen from a set of points compared to the other two cost mixing methods.

Based on the results of calculating total production costs using the high-low point method and the least square method, it can be seen in Table 4.4 below:

Table 4.4 For June Estimates 189,000 Tofu Units

No	Information	high-low point method	least squares method
1	Fixed cost	IDR 59,281,740	IDR 100,797,921
2	Variable Costs	IDR 47,093,508	Rp (247,301)
3	Production cost	IDR 106,375,246	IDR 100,523,619

Source: Processed data, 2023

Based on Table 4.4, an estimate can be obtained for tofu production units in June of 189,000 units and production costs obtained at 106,375,246 for the high-low point method and IDR 100,523,619 for the least square method.

Estimates for June for production costs and tofu production units, Banda Aceh Ayam Jago Tofu and Tempe Factory can use the least squares method because this method can be calculated from a set of data points so it will be immediately known for production costs and production units. This is different from the high-low point method which only looks at the highest and lowest point of production cost activities, the highest and lowest production units. Separating fixed costs and variable costs using the high-low point method and least squares method produces different fixed costs and variable costs.

5.0 CONCLUSIONS AND RECOMMENDATIONS

Conclusion

The aim of the research, which is based on the discussion of this final project which has been explained in the previous chapters, is to calculate the total production costs using the high-low point method and the least square method, so several conclusions can be concluded as follows:

1 The Banda Aceh rooster tofu and tempeh factory does not calculate production costs.
2 The estimated amount of tofu production in June is 189,000 units with a total production cost calculation of 106,375,246 for the high-low point method and IDR 100,523,619 for the least squares' method.

Recommendations

Based on the results of this research, there are several suggestions as follows:

1. The Banda Aceh Rooster Tofu and Tempeh Factory can apply calculations using the least squares method, because these costs are seen from a set of data points and can be used as a tool in making decisions to estimate production costs in the future, especially being able to separate variable costs and fixed costs in this business.

2. It is hoped that future researchers can increase the period and use the mixed-cost separation method.

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