Non-linear equity model for measuring patchouli oil at various levels

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Abstract. Indonesian patchouli agroindustry involving many actors is one of the sectors that should be developed because it supplies most of the global patchouli oil. One thing that should be considered in the agroindustry development is the inequity of benefits among actors involved. The inequity is assumed to have made producers (farmers/distillers), as very decisive parties in the fulfillment of global market demands, i.e. the stability of supply and quality assurance of oil, unable to fulfill it. The main objective of this research is to develop a non-linear equity model to measure patchouli oil sales price at various transaction levels in order to ensure that all local value chain actors, especially farmers, distillers, and middlemen, get an equivalent ratio of benefits over their expenses. The return on investment (ROI) was chosen as an indicator because with the same ROI it can explain that each type of business in the patchouli value chain has the same attractiveness for investment, and all actors will get an equal ratio benefit (net profit) over their expenses (costs). The research was done in Gayo Lues District, Indonesia. Research findings recommend that to produce equal benefit among the actors, sales price per kg oil must be about IDR 536,718.55 for farmers; IDR 565,360.71 for distillers and medium middlemen and IDR 595,565.95 for middlemen.

1. Introduction
Indonesian is the main exporter of patchouli oil as about 90% of patchouli oil transacted on the global market comes from Indonesia [1];[2]. It is estimated that from 2014 – 2018, the production volumes of Indonesian patchouli oil are between 1,988 - 2,206 tons/year, while the global demand is around 2,000 tons - 2,200 tons/year with an increase in demand around 5%/year [3]. The other two key producing countries are the People's Republic of China and India, but they are not involved in the global market and focusing on their own domestic demands instead. The global market requires many things, including the stability of supply, consistent of quality, and predicted price based on quality [2]; [4]. However, to meet the demands, the producers (farmers/distillers) face many problems, such as: lacks implementations of the Good Agriculture Practices (GAP) in patchouli cultivation as well as the Good Manufacture Practices (GMP) in the distillation process, and price fluctuations of the patchouli oil [3]. The lacks of GAP and GMP implementations allegedly are because the producers get the least benefits.
(inequity) from patchouli business or among actors in patchouli value chains [5]; [6] due to the unfair sales prices set. While, the price fluctuations, besides due to the absence of market transparency [3], it is also dominantly affected by the fluctuations of patchouli oil supply [7]. Therefore, the stakeholders should pay more attention to overcome these phenomena, where all actors should get fair sales prices in order to ensure equal benefit among actors within the value chain.

Some models have been developed to determine the fair sales prices for actors in the patchouli oil business. Indrawanto and Yuhono calculated the sales prices based on the break-even point (BEP) value of farmers and distillers plus an agreed net margin to provide a reasonable profit. Prices for other actors are further set by manually adding reasonable net margins [8]. Hendrastuti et al. developed a model by using Fibonacci technique to optimize the sales price of farmers and the purchasing price of distillers in order to obtain a fair profit for both [9]. Widaranti developed a model to determine sales prices by differentiating net margins between value chain actors based on the percentage of cost per kg spent by each value chain actor to produce 1 (one) kg of patchouli oil [6]. Weaknesses of the model proposed by Widaranti are as shown by Rahmayanti et al. [5], who found the differences in net margin between value chain actors in transactions per kg of patchouli oil, where farmers got the largest net margin, followed by middlemen II and middlemen I. However, from the calculation of net margin per working day, the opposite results were obtained, where middlemen I got the largest net margin per working day, followed by middlemen II and farmers. In this case, it is emphasized the need to consider the time factor required to obtain the net profit (net margin). Therefore, this study offers the use of ROI as an alternative financial indicator in measuring equality so that the prices generated at each transaction level are fairer. An equal ROIs indicates that each value chain actor gets the same proportion of return over the costs they expensed because the true ROI value is the ratio of the returns divided by the cost multiplied by 100%. ROI, although simple, is quite flexible and is commonly used in comparing various investments in the private sector. In comparing several different types of businesses, the ROI value for each type of business is calculated over the same period, for example per year. In addition, the standard approach in ROI analysis if returns and costs occur for more than one period is to calculate the ROI value by discounting future benefits and costs to present the current value [10].

2. Materials and methods

2.1. Research locations and data collections
The research was done on March – April 2018 in Gayo Lues District, Aceh Province, Indonesia. Located on a high altitude, Gayo Lues provides a very high patchouliol (patchouli alcohol) content of patchouli oil. However, majority oil produced (>90%) is dark variant patchouli oil, which contaminated with iron from low yield asphalt drum (non-GMP) distillation units. Furthermore, it is estimated that the monthly production of Gayo Lues patchouli oil is approximately 40 tons/year, where the Tripe Jaya and Terangon Sub-districts were two main production areas [11].

Data collections were started by identifying the actors involved in the value chain. Then, some important data were also recorded, such as the existing distribution channels, financial data of all actors, and monthly supplied and sales prices of patchouli oil in the local market. The data were collected by using surveys and in-depth interviews with farmers, distillers, middlemen, and representatives of Central Agency on Statistics (BPS) in Gayo Lues.

2.2. Development of the equity model
Figure 1 presents the most efficient (the shortest) distribution channel of patchouli oil in Gayo Lues involving 3 (three) actors, where farmers and distillers share the oil after distillation process based on agreed oil share ratio (farmer: distiller = 8.5: 1.5), then independently sell the oil to (big) middlemen; whereas farmers in many areas of Indonesia usually sell the patchouli leaves to distillers [12]; [13].
To develop the model, we first have to describe equations of total revenue (TR), total cost (TC), and ROI of the actors based on Figure 1, as follows:

1) Farmers:
   - TR from sales of Q1 oil is TR1 = P1.Q1 (1)
   - TC to produce Q1 + Q2 oil is TC1 = C1.(Q1 + Q2) (2)
   - Thus, ROI1 = \( \frac{P1.Q1 - C1.(Q1 + Q2)}{C1.(Q1 + Q2)} = \frac{P1.Q1}{C1.(Q1 + Q2)} - 1 \) (3)

2) Distillers:
   - TR from sales of Q2 oil is TR2 = P2.Q2 (4)
   - TC to produce Q1 + Q2 oil is TC2 = C2.(Q1 + Q2) (5)
   - Thus, ROI2 = \( \frac{P2.Q2 - C2.(Q1 + Q2)}{C2.(Q1 + Q2)} = \frac{P2.Q2}{C2.(Q1 + Q2)} - 1 \) (6)

3) Middlemen
   - TR from sales of Q3 oil is TR3 = P3.Q3 - (P1.Q1 - P2.Q2). Because P1 = P2 and Q3 = Q1+Q2, then:
     \[ TR3 = (P3 - P1).Q3 \] (7)
   - TC to purchase Q3 oil is TR3 = C3.Q3 = C3a.Q3a + (P1.Q1 + P2.Q2).\( \frac{i3}{n3} \) = (C3a + P1.\( \frac{i3}{n3} \)).Q3 (8)
   - Thus, ROI3 = \( \frac{(P3 - P1).Q3 - (C3a + P1.\frac{i3}{n3}).Q3}{(C3a + P1.\frac{i3}{n3}).Q3} = \frac{P3 - P1}{C3a + P1.\frac{i3}{n3}} - 1 \) (9)

ROI\( s \) of farmers and distillers, as shown in equations 3 and 6, depending on the patchouli oil share ratio between them. The ideal oil share ratio (\( \eta \)) can be obtained from ROI1 = ROI2 \( \Leftrightarrow \frac{P1.Q1}{C1.(Q1 + Q2)} - 1 = \frac{P2.Q2}{C2.(Q1 + Q2)} - 1 \) (10)
\[ \frac{P1.Q1}{C1.(Q1 + Q2)} - 1 \Leftrightarrow \frac{P1.Q1}{C1} = \frac{P2.Q2}{C2} \] or \( \frac{Q1}{Q2} = \frac{C2.P2}{C2.P1} \) (11)
\[ \eta = \frac{Q1}{Q2} = \frac{C2.P2 + C2.P1}{C2.P1} \] (12)

**Figure 1.** The distribution channel of Gayo Lues patchouli oil.

**Note:** Q are quantities supplied; C are production/marketing costs; and P are sales prices of the actors: farmers (1), distillers (2), and middlemen (3). Also, \( P1 < P2 < P3 \); and \( Q1 + Q2 = Q3 \).
At an optimum state ($\text{ROI}_1 = \text{ROI}_2$), by substituting equations 11 and 12 into equations 3 and 6, both equations (3 and 6) can be also written as $\text{ROI}_1 = \text{ROI}_2 = \frac{2P_1P_2}{C_1P_2 + C_2P_1} - 1$ (13)

**Decision variables**

The decision variables are sales prices of farmers ($P_1$); distillers ($P_2$); and middlemen ($P_3$).

**Objective function**

The objective function is to minimize the ROI deviation of each actor with an ideal (maximum) ROI, which is symbolized as $M$ (Big M). Thus, the mathematical model of the objective function will be $\text{Min. } \sum_{j=1}^{m} \Delta \text{ROI}_j = \sum_{j=1}^{m} M - \text{ROI}_j$ (14)

Where $M$ is ideal ROI for every actor; and $\text{ROI}_j$ is ROI of actor-$j$.

**Constraints**

The constraints to achieve the objective function consist of:

1) Profitability constraint. To ensure a business is profitable, for each actor, total revenue is larger than total cost: $\text{TR}_j > \text{TC}_j$ (15)

Where $\text{TR}_j$ is the total revenue of actor-$j$ and $\text{TC}_j$ is the total cost of actor-$j$.

2) Price stability constraint. This constraint is aimed to avoid high fluctuation of quantity supplied in the local market; therefore, it is essential to limit the range of sales price. The equation of this constraint is $P_{t \text{ lower stability}} < P_{m-1} < P_{t \text{ upper stability}}$ (16)

Where $P_{m-1}$ is the sales price of the oil to middlemen ($P_1 = P_2$). In this article, the range was limited by using statistical process control (SPC) method, a statistical method commonly used in analyzing and improving processes, especially in the quality control [14].

3) Quantity supplied constraint. Based on the distribution channel, the constraint can be formulated as: $\sum_{j=1}^{n-1} Q_j = Q_n$ (17)

Where $Q_j$ is the quantity of oil supplied by actor/s $j$; $Q_n$ is the quantity of oil purchased by actor $n$.

4) Equivalent ROI constraint. $\text{ROI}_1 = \text{ROI}_2 = \ldots = \text{ROI}_i = \frac{\text{Net Profit actor}-j}{\text{Cost of investment of actor}-j} \times 100\%$ (18)

The equations of ROIs for all actors are as described above.

5) General price constraints:

- $P_1 = P_2 < P_3$ (19)

- $P_1, P_2, P_3 > 0$ (20)

The model requires the following specific input data: $C_1, C_2, C_{3a}, n_3, i_3, P_1 \text{ lower stability}$; and $P_1 \text{ upper stability}$. Where $C_1$ is production cost/kg oil of farmers; $C_2$ is production cost/kg oil of distillers; $C_{3a}$ is marketing cost/kg oil of middlemen without loan interest costs of invested capital to purchase oil; $i_3$ is a discount factor of middlemen; $n_3$ is total frequencies of transactions between middlemen and buyers per year; $P_1 \text{ lower stability}$ is lower price stability constraint; $P_1 \text{ upper stability}$ is upper price stability constraint. The executed model will produce optimum values of $Z$, $P_1$, $P_2$, and $P_3$. Patchouli oil share ratio between farmers and distillers was calculated by using equations 10, 11, and 12.

**Sensitivity analysis**

Sensitivity analysis was used to evaluate how much the optimum (equal) ROIs, patchouli oil share ratio between farmers and distillers, and average profits per kg for middlemen change with the following scenarios: (1) $P_{t \text{ lower stability}}$ increases by 2.5% (a) and 5% (b); also $P_{t \text{ upper stability}}$ decreases by 2.5% (a) and 5% (b) which means that monthly prices will be less volatile; (2) $P_{t \text{ lower stability}}$ decreases by 2.5% (a) and 5% (b); also and $P_{t \text{ upper stability}}$ increases by 2.5% and 5%, which means that monthly prices will be more volatile.

3. Results and discussion

3.1. Existing sales prices of patchouli oil in Gayo Lues

Summary of the existing financial data summary for each actor in the value chain is as shown in Table 1, where the sales prices of farmers and distillers are IDR 506,666.67/kg and the sales price of middlemen is IDR 586,667/kg. Table 1 also indicates that the ROIs of the actors are unequal. The ROI
of middlemen is too large because the gross profit set is too high (IDR 80,000/kg of patchouli oil) and the ROI of traditional distillers is too small because the oil share ratio (farmer: distiller = 8.5: 1.5) is more profitable for farmers. Furthermore, based on the data presented in the table, we secured input data of the model as follows: \( C_1 = 213,549.38 \text{ IDR/kg oil} \); \( C_2 = 67,509.92 \text{ IDR/kg oil} \); \( C_{3a} = 10,915.41 \text{ IDR/kg} \); \( i_3 = 10\% \); \( n_3 = 12 \text{ (transactions frequencies of sales/year)} \).

| Table 1. Current financial performance of Gayo Lues Patchouli oil actors. |
|---------------------------------|-----------------|-----------------|-----------------|
| **Actors**                      | **Farmers**     | **Distillers**  | **Middlemen**   |
| Productions or sales frequencies| Semi-annually, 2 harvest periods/year | Daily, 2 batches/day, 24 working days/month | Monthly, about 12 transaction frequencies/year |
| Business capacities             | The patchouli cultivation produces about 162 kg oil/ha/year, where farmers hold about 137.7 kg oil/ha at current “farmers: distillers = 8.5: 1.5” oil share ratio. | Each distillation unit process about 35 kg dried leaves/batch producing about 1.4 kg oil/day = 403.2 kg oil/year | Each middleman manages about 578.75 kg oil/month = 6,945.00 kg oil/year |
| Average sales prices of patchouli oil (IDR/kg) | 506,666.67 | 506,666.67 | 586,667 |
| Ann. incomes (IDR)              | 67,768,000/ha | 30,643,200/distiller | 555,600,000/middleman |
| Total ann. costs (IDR)          | 34,595,000/ha | 27,220,000/distiller | 105,130,833/middleman |
| Ann. fixed costs (IDR)          | 3,520,000/ha | 700,000/distiller | 16,590,000/middleman |
| Ann. variable costs (IDR)       | 31,075,000/ha | 26,520,000/distiller | 88,584,833/middleman |
| Net profit/year                | 35,173,000/ha | 3,423,200/distiller | 555,600,000/middlemen |
| Total cost/kg oil produced (IDR/kg) | 213,549.38 | 67,509.92 | 15,137.63 |
| Total cost/kg oil owned or purchased (IDR/kg) | 251,234.57 | 450,066.14 | 15,137.63 |
| Net profit/kg (IDR/kg)          | 255,432.10 | 56,600.53 | 64,862.37 |
| Gross profit/kg (IDR/kg)        | -              | -              | 80,000.00 |
| Return of Investment (ROI)      | 101.7%         | 12.6%          | 428.5%         |

1) including IDR 29,323,333 total annual loan interest of the capital invested to purchase ±578.75 kg oil/month or ±6,945 kg oil/year (= IDR 4,222/kg) at 10% of discount factor; and IDR 10,915.41 marketing cost/kg without the loan interest cost.

2) the gross profit margin set is Rp. 60,000/kg - Rp. 100,000/kg or an average of Rp. 80,000/kg.

To complete the input data of the model, the price stability constraints also must be determined because the common phenomenon in the market is that changes in prices (P) affect the quantity supplied (Q) of agricultural commodities or vice versa. Thus, maintaining the sales price or reducing the sales price fluctuation is very important, so that the amount of supply also tends to be stable and makes it easier for the actors to carry out production and marketing plans. Figure 2 shows the monthly price of (dark variant) patchouli oil in Gayo Lues from July 2015 to December 2017 and Figure 3 shows the detailed fluctuations of the monthly price. The SPC technique used was the Individual control chart and moving range (I-MR), which produces a centerline (CL) 506,667, upper control limit (UCL) = 565,361, and lower control limit (LCL) of 447,973 for the monthly price. Thus, the recommended prices range for (dark variant) patchouli oil per month is between IDR 447,973/kg (\( P_{\text{lower stability}} \)) and IDR 565,361/kg (\( P_{\text{upper stability}} \)) or IDR 447,973/kg ≤ \( P_1 \) = \( P_2 \) ≤ IDR 565,361/kg.
If the secured input data are entered into the model, the model will be as follows: \( Z = f (P) \): objective function: 

\[
\min Z = M + 3 - \left( \frac{p_1}{281059.30} + \frac{p_2}{281059.30} + \frac{p_3 - p_1}{10915.41 + 0.00833p_1} \right)
\]

Subject to: 
1. linear inequalities: 1.00833. \( p_2 - p_3 \leq -10915.42 \); 
2. linear equalities: \( p_1 - p_2 = 0 \); 
3. lower bounds: \( p_1 = 447972.61 \); \( p_2 = 447972.61 \); \( p_3 = 462621.12 \); 
4. upper bounds: \( p_1 = 565360.72 \); \( p_2 = 565360.72 \); \( p_3 = \infty \); 
5. nonlinear Constraints: \( 0.00633p_1^2 + 221842.93p_1 - 213549.38p_3 = 0 \); 
6. start point: \([447972.62; 447972.62; 462621.13]\).

### 3.2. Optimal sales prices of patchouli oil in Gayo Lues

The model completion was done using the FMINCOM module in MATLAB together with the Microsoft Excel software package. The comprehensive solutions of the model are as shown in Table 2, where the ROIs of the actors are now equal. The output model suggests that sales prices of patchouli oil owned by farmers and distillers are increased by IDR 58,693.99, and the sales price of patchouli oil

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**Figure 2.** Individual control chart of Gayo Lues patchouli oil.

**Figure 3.** Moving range control chart of Gayo Lues patchouli oil.
belonging to middlemen is increased by IDR 10,125.23, although the gross profit per kg of the middlemen will be much lower overall. Optimal (equal) ROI is around 101.2%, while the ideal profit-sharing ratio between farmers and refiners is 3.16:1. Additionally, because farmers and distillers sell patchouli oil to the same party (middlemen), with the same total cost per kg of oil, they require the same net profit at the optimal (equal) ROI.

### Table 2. Optimal financial performance of Gayo Lues Patchouli oil actors.

| Actors          | Farmers         | Distillers      | Middlemen       |
|-----------------|-----------------|-----------------|-----------------|
| Productions or sales frequencies | Semi-annually, 2 harvest periods/year | Daily, 2 batches/day, 24 working days/month | Monthly, about 12 transaction frequencies/year |
| Business capacities | The patchouli cultivation produces about 162 kg oil/ha/year, where farmers hold about 123.09 kg oil/ha at an optimal “farmers:distillers = 3.16:1” oil share ratio. | Each distillation unit process about 35 kg dried leaves/batch producing about 1.4 kg oil/day = 403.2 kg oil/year | Each middleman manages about 578.75 kg oil/month = 6,945.00 kg oil/year |
| Average sales prices of patchouli oil (IDR/kg) | 565,360.66 | 565,360.66 | 596,791.90 |
| Ann. incomes (IDR) | 69,589,058/ha | 54,753,986/distiller | 218,289,959/middleman |
| Total ann. costs (IDR) | 34,595,000/ha | 27,220,000/distiller | 108,527,748/middleman |
| Ann. fixed costs (IDR) | 3,520,000/ha | 700,000/distiller | 16,590,000/middleman |
| Ann. variable costs (IDR) | 31,075,000/ha | 26,520,000/distiller | 91,937,748/middleman |
| Net profit/year | 34,994,058/ha | 27,533,986/distiller | 109,762,211/middlemen |
| Total cost/kg oil produced (IDR/kg) | 213,549.38 | 67,509.92 | 15,626.75 |
| Total cost/kg oil owned or purchased (IDR/kg) | 281,059.30 | 281,059.30 | 15,626.75 |
| Net profit/kg (IDR/kg) | 284,301.36 | 284,301.36 | 15,804.49 |
| Gross profit/kg (IDR/kg) | - | - | 31,431.24 |
| Return of Investment (ROI) | 101.2% | 101.2% | 101.2% |

1) including IDR 32,720,248 total annual loan interest of the capital invested to purchase ±578.75 kg oil/month or ±6,945 kg oil/year (± IDR 4,711/kg) at 10% of discount factor; and IDR 10,915.41 marketing cost/kg without the loan interest cost.

Furthermore, sensitivity analysis results are as shown in Tables 3, 4, 5, and 6. The tables indicate that:

1) In scenarios 1 and 2, the change (decrease or increase) in ROI is proportional to the change (decrease or increase) in the $P_{1,upper}$ stability value.

2) In Scenarios 1 and 2, changes (decrease or increase) in the price of patchouli oil per kg for each actor will also change (increase or decrease) the $P_{1,upper}$ stability value. However, the magnitude of the change is slightly different between value chain actors, from the smallest to the largest are farmers, distillers, then middlemen.

3) Changes in scenarios 1 and 2 hardly affect the changes in the oil share ratios between farmers and refiners.

4) Changes (decrease or increase) in gross profit per kg of middlemen is almost proportional to the change (decrease or increase) in the $P_{1,upper}$ stability value.
### Tabel 3. Sensitivity analysis result of scenario 1a.

| No. | Actors         | Initial optimized model | Optimized model for scenario 1a | Changes |
|-----|----------------|-------------------------|---------------------------------|---------|
|     |                | Sales price per kg (IDR/kg) | ROI               | Sales price per kg (IDR/kg) | ROI | (3) - (1) | (4) - (2) |
| 1   | Farmers        | 565,360.66              | 101.2%              | 551,226.71                  | 96.1% | -14,133.95 | -5.0% |
| 2   | Distillers     | 565,360.66              | 101.2%              | 551,226.71                  | 96.1% | -14,133.95 | -5.0% |
| 3   | Middlemen      | 596,791.90              | 101.2%              | 581,641.23                  | 96.1% | -15,150.67 | -5.0% |

Oil share ratio (farmers: distillers): 3.16:1
Gross profit per kg for middlemen: 31,431.24

### Tabel 4. Sensitivity analysis result of scenario 1b.

| No. | Actors         | Initial optimized model | Optimized model for scenario 1b | Changes |
|-----|----------------|-------------------------|---------------------------------|---------|
|     |                | Sales price per kg (IDR/kg) | ROI               | Sales price per kg (IDR/kg) | ROI | (3) - (1) | (4) - (2) |
| 1   | Farmers        | 565,360.66              | 101.2%              | 537,092.63                  | 91.1% | -28,268.03 | -10.1% |
| 2   | Distillers     | 565,360.66              | 101.2%              | 537,092.63                  | 91.1% | -28,268.03 | -10.1% |
| 3   | Middlemen      | 596,791.90              | 101.2%              | 566,502.27                  | 91.1% | -30,289.63 | -10.1% |

Oil share ratio (farmers: distillers): 3.16:1
Gross profit per kg for middlemen: 31,431.24

### Tabel 5. Sensitivity analysis result of scenario 2a.

| No. | Actors         | Initial optimized model | Optimized model for scenario 2a | Changes |
|-----|----------------|-------------------------|---------------------------------|---------|
|     |                | Sales price per kg (IDR/kg) | ROI               | Sales price per kg (IDR/kg) | ROI | (3) - (1) | (4) - (2) |
| 1   | Farmers        | 565,360.66              | 101.2%              | 579,494.68                  | 106.2% | 14,134.02 | 5.0% |
| 2   | Distillers     | 565,360.66              | 101.2%              | 579,494.68                  | 106.2% | 14,134.02 | 5.0% |
| 3   | Middlemen      | 596,791.90              | 101.2%              | 611,954.49                  | 106.2% | 15,162.59 | 5.0% |

Oil share ratio (farmers: distillers): 3.16:1
Gross profit per kg for middlemen: 31,431.24
Tabel 6. Sensitivity analysis result of scenario 2b.

| No. | Actors      | Initial optimized model | Optimal model for scenario 2b | Changes |
|-----|-------------|--------------------------|-------------------------------|---------|
|     |             | Sales price per kg (IDR/kg) | ROI   | Sales price per kg (IDR/kg) | ROI   | (3) - (1) | (4) - (2) |
| 1   | Farmers     | 565,360.66               | 101.2% | 593,628.70                 | 111.2% | 28,268.04 | 10.1%     |
| 2   | Distillers  | 565,360.66               | 101.2% | 593,628.70                 | 111.2% | 28,268.04 | 10.1%     |
| 3   | Middlemen   | 596,791.90               | 101.2% | 627,128.91                 | 111.2% | 30,337.01 | 10.1%     |

Oil share ratio (farmers: distillers): 3.16: 1
Gross profit per kg for middlemen: 31,431.24

4. Conclusions

The traditional distillers are the least benefited actors in the value chain (the smallest ROI value), while the middlemen are the most benefited the most ones (the greatest ROI value) due to the sales prices set. To ensure equity among the actors, outputs of the model recommends the prices at various transaction levels are IDR 565,360.66 for farmers and distillers; and 596,791.90 for the middlemen, at an ROI equivalent of 101.2%; whereas the ideal ratio for the results between farmers and distillers is 1: 3.16. For further development, several things can be included in the model development, such as considering an analysis of the risks borne by the actors and their qualitative impact on equity; using alternative financial indicators as a comparison of equity besides the ROI; and applying the equality model in other fields or commodities.

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