

# Optimizing

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## Optimizing Product Mix Using Linear Programming: A Case Study of ‘Kopi Sembilan’

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Small and Medium Enterprises (SMEs) in East Java—Indonesia, has been proven to make a major contribution to the Gross Domestic Income. Nevertheless, production management that is applied often still traditional. This research is a case study conducted in one of the coffee bean processing SMEs is “Kopi Sembilan,” and aims to determine the composition of the most optimal product sales of nine kinds of processed coffee products. The results using the method of linear programming showed that the most optimal products mix per day is Kopi Caffe Dos total of 133 boxes, Kopi Krishna “9” (20 packs), Kopi Aroma “9” (20 packs), Kopi Robusta “9” A1 (25 packs), Kopi Robusta Plastik (30 packs), Kopi Robusta Mantap (31 packs), Kopi Robusta Plus Jahe “9” (20 packs), Kopi Jawara “9” (14 packs), and Kopi Luwak “9” as much as 8 packs. These results provide the most optimal profit compared with the previous determination traditional product mix.

**Keywords:** Product Mix, Coffee, Linear Programming.

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### 1. INTRODUCTION

It is undeniable that the Micro, Small, and Medium Enterprises (SMEs) has contributed greatly to the national income. There are approximately 56.54 million units of SMEs in Indonesia, which contribute about 60% of Gross Domestic Product.<sup>1</sup> Further stated that the field of SMEs which contribute most consecutive GDP is agriculture, followed by trade sector, hotels and restaurants, and the manufacturing sector. The previous study of three provinces in Java, namely West Java, Central Java and East Java showed that in general the Small and Medium Enterprises (SMEs) ownership is still domestically, managed traditionally, and still domestically oriented.<sup>2</sup>

“Kopi Sembilan” is one of the SMEs engaged in the processing of coffee beans and is located in Sukorejo, Pasuruan-Indonesia. It has had 9 product variants, namely Kopi Caffe Dos, Kopi Krishna “9”, Kopi Aroma “9”, Kopi Robusta “9” A1, Kopi Robusta Plastik, Kopi Robusta Mantap, Kopi Robusta Plus Jahe “9”, Kopi Jawara “9”, and Kopi Luwak “9”. As the characteristics of SMEs in general, the typical business management is still a domestic with the use of technology is quite simple. Determination of the product mix sold during this variant also still use the traditional way by estimates only.

Several studies have shown that there are many factors that can improve the productivity and performance of SMEs, such as innovation, use of new technology, network and relational, linear

programming implementation, and knowledge management.<sup>3-6</sup> Previous study has also shown that organizational innovation has a higher impact on small firms.<sup>7</sup>

Increased productivity of small and medium enterprises will develop the economic and industrial conditions. Linear programming techniques can be used in maximizing profits through increased productivity, not decision-making by trial and error by managers.<sup>5</sup> Under these conditions, the purpose of this study is to establish the most optimal product mix with linear programming method to obtain the maximum benefit with some restrictions faced.

### 2. METHOD

This research uses quantitative approach. Quantitative analysis is a scientific approach to managerial decision making.<sup>8</sup> Managerial decisions can be based on different methods, and usually starts from real world modeling. One popular method used is linear programming. Previous studies showed that 93.7% of SMEs do not have the knowledge of linear programming for decision making.<sup>9</sup>

Linear programming is a mathematical modeling technique in which has an objective function that includes variable decisions, as well as the function of the constraints of limited resources, which are used to achieve the optimal solution to a problem that has a series of constraints that bind a purpose. If the problems faced quite simple with only two decision variables, then approach the graphical method used. For more complex

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**Table 1. The needs raw materials and production costs per month.**

Requirement of raw materials and labor	Raw materials (kg) and the hours of labor max capacity				
	Kopi Caffe Dos	Kopi Krisna "9"	Kopi Aroma "9"	Kopi Robusta "9" A1	Kopi Robusta Plastik
Demand	3333	500	500	625	750
Profit margin (owner version) (%)	40	40	40	40	40
Packaging (g)	150	150	200	200	200
Selling price (IDR)	18.000	16.000	20.000	13.000	11.000
The average production per day	120	15	15	20	25
Raw material needs of robusta coffee beans (kg)		75	100	125	150
Purchase price (IDR) per kg		30.000	30.000	27.000	25.000
Purchase price (IDR) per gram pack		4.500	6.000	5.400	5.000
Capital raw materials of robusta coffee (IDR)		2.250.000	3.000.000	3.375.000	3.750.000
Raw material needs of arabica coffee beans (kg)	500				
Purchase price (IDR) per kg	50.000				
Purchase price (IDR) per gram pack	7.500	0	0	0	0
Capital raw materials of arabica coffee (IDR)	25.000.000	0	0	0	0
Raw material needs of ginger (kg)					
Purchase price (IDR) per kg					
The purchase price per package (IDR/package g)	0	0	0	0	0
Capital raw materials ginger (IDR)	0	0	0	0	0
Needs raw materials of aluminium foil (sheet)	300	1000	1200	500	500
Needs of aluminium foil per pack (sheets)	0.09	2	2.4	0.8	0.67
Purchase price (IDR) per sheet	1.300	800	1.500	700	350
Capital raw materials of aluminium foil (IDR)	390.000	800.000	1.800.000	350.000	175.000
Raw material needs of stickers (sheet)	500	1500	1500	700	700
Needs of sticker per pack (sheets)	0.15	3.0	3.0	1.12	0.93
Purchase price (IDR) per sheet	250	250	500	250	250
Capital raw materials of stickers (IDR)	125.000	375.000	750.000	175.000	175.000
Seals plastic raw material requirement (kg)	500	1200	1400	5100	600
Seals plastic needs per pack (gram)	150	2400	2800	8160	800
Purchase price (IDR) per kg	75	75	75	75	75
Purchase price per gram pack	11	11	15	15	15
Capital of seal plastic raw materials (IDR)	37.500	90.000	105.000	382.500	45.000
Raw material needs of civet arabica beans (kg)					
Purchase price (IDR/kg)					
Purchase price per package (IDR/gram pack)	0	0	0	0	0
Capital raw materials of arabica civet coffee (IDR)	0	0	0	0	0
Needs of work hours for workers packing section (days)	2	3	4	3	3
Wages/day (IDR/day)	25.000	25.000	25.000	25.000	25.000
Number of workers (man)	2	2	2	2	2
	100.000	150.000	200.000	150.000	150.000
Needs of work hours for workers delivery section (days)	2	2	2	2	2
Wages/day (IDR/day)	25.000	25.000	25.000	25.000	25.000
Number of workers (man)	2	2	2	2	2
	100.000	100.000	100.000	100.000	100.000
Needs of LPG gas (IDR)	45.000	45.000	45.000	45.000	45.000
Needs of transportation costs (IDR)	75.000	75.000	75.000	75.000	75.000

  

Raw materials (kg) and the hours of labor max capacity				
Kopi Robusta Mantap	Kopi Robusta + Jahe "9"	Kopi Jawara "9"	Kopi Luwak "9"	Max capacity
775	375	350	20	
40%	40%	40%	40%	
200	200	200	100	
12.000	14.000	5.000	130.000	
30	15	12	5	
155	100	70		775
25.000	25.000	20.000		
5.000	5.000	4.000	0	
3.875.000	2.500.000	1.400.000	0	
0	0	0	0	500
0	0	0	0	
	500			500
	19.000			
0	3.800	0	0	
0	9.500.000	0	0	
700	800	700	150	5,850
0.9	2.13	2.0	7.5	18.49
350	800	500	800	

Table I. Continued.

Raw materials (kg) and the hours of labor max capacity				
Kopi Robusta Mantap	Kopi Robusta + Jahe "9"	Kopi Jawara "9"	Kopi Luwak "9"	Max capacity
245.000	640.000	350.000	120.000	
800	1500	1000	850	9,050
1.03	4	2.86	42.50	58.59
250	250	250	250	
200.000	375.000	250.000	212.500	
800	900	800	200	11,500
1,032.26	2,400	2,285.71	10,000	30,028
75	75	75	75	
15	15	15	19	
60.000	67.500	60.000	15.000	
			20	20
			800.000	
0	0	0	60.000	
0	0	0	16.000.000	
3	3	2	2	25
25.000	25.000	25.000	25.000	
2	2	2	2	
150,000	150,000	100,000	100,000	
2	2	2	1	25 days
25.000	25.000	25.000	25.000	
2	2	2	1	
100.000	100.000	100.000	25.000	
45.000	45.000	45.000	15.000	375.000
75.000	75.000	75.000	50.000	650.000

Table II. Production per day for each packaging.

Type	Production per day for each package	Capacity/ packaging (g)	Required time per package (min)	Capacity/ packaging (g)
Kopi Caffe Dos	133.33	100	0.6	33.33
Kopi Krisna "9"	20	100	0.6	33.33
Kopi Aroma "9"	20	75	0.8	25
Kopi Robusta "9" A1	25	75	0.8	25
Kopi Robusta Plastik	30	75	0.8	25
Kopi Robusta Mantap	31	75	0.8	25
Kopi Robusta + Jahe "9"	20	75	0.8	25
Kopi Jawara "9"	14	75	0.8	25
Kopi Luwak "9"	8	150	0.4	50
Roasting machine				
Capacity	15,000			Gram
Processing time	60			Minutes
Milling machine				
Capacity	5,000			Gram
Processing time	60			Minutes
Electricity cost				
Watt	250			Watt
In kwh	0.25			kwh
Cost/kwh	1.460			IDR
Required time per package (min)	Total cost of electricity per pack (IDR)	Cost of capital (IDR)/ packaging unit	Cost (IDR)/gram for each pack	
1.8	10,95	9.061	60,41	
1.8	10,95	5.561	37,08	
2.4	14,60	8.075	40,38	
2.4	14,60	6.365	31,83	
2.4	14,60	5.615	28,08	
2.4	14,60	5.615	28,08	
2.4	14,60	9.925	49,63	
2.4	14,60	3.765	18,83	
1.2	7,30	61.125	611,25	

Production per day:  $x_1 \leq 133; x_2 \leq 20; x_3 \leq 20; x_4 \leq 25;$

$x_5 \leq 30; x_6 \leq 31; x_7 \leq 20; x_8 \leq 14; x_9 \leq 8$

$x_1, x_2, x_3, x_4, x_5, x_6, x_7, x_8, x_9 \geq 0$

Where:  $x_1$ : Kopi Caffe Dos (150 g),  $x_2$ : Kopi Krisna "9" (150 g),  $x_3$ : Kopi Aroma "9" (200 g),  $x_4$ : Kopi Robusta "9" A1 (200 g),  $x_5$ : Kopi Robusta Plastik (200 g),  $x_6$ : Kopi Robusta Mantap (200 g),  $x_7$ : Kopi Robusta Plus Jahe "9" (200 g),  $x_8$ : Kopi Jawara "9" (200 g),  $x_9$ : Kopi Luwak "9" (100 g).

By utilizing software QM for Windows version 3.2, the obtained optimum conditions as shown in Table IV. From Table IV, it can be shown that the relative product mix increases more than current production. For the production per day, Kopi Caffe Dos can be produced as many as 133 boxes, Kopi Krisna "9" as much as 20 packs, Kopi Aroma "9" as much as 20 packs, 25 packs for Kopi Robusta "9" A1, Kopi Robusta Plastik as much as 30 packs, Kopi Robusta Mantap produced as much as 31 packs, Kopi Robusta + Jahe "9" of 20 packs, Kopi Jawara "9" as many as 14 packs, and Kopi Luwak "9" although the market absorb the least, but is able to be produced as many as eight packs.

These results show that with the support of knowledge, especially operations research, managers can make more real decision-making and not just trial and error. It is therefore necessary to strengthen the quality and scope of entrepreneurial skills in the sector.<sup>10</sup> Training for managerial personnel in this sector needs to be given especially on improving understanding in applying operational research in decision making.

The determination of product mix through linear programming must be followed by other managerial actions, because one measure of success is whether small medium enterprises are able to sell their products in the market. In the face of increasingly fierce competition, a complete understanding of the statistics and the

Table III. Resource use and production per day.

	Selling price (IDR)	Capital (IDR)	Work hours (minutes)	Raw material (IDR)	Market demand (production per day)	Profit (IDR)
Kopi Caffe Dos	18.000	9.144	2.4	9.061	120	8.856
Kopi Krisna "9"	16.000	5.898	2.4	5.561	15	10.102
Kopi Aroma "9"	20.000	8.564	3.2	8.075	15	11.436
Kopi Robusta "9" A1	13.000	6.674	3.2	6.365	20	6.635
Kopi Robusta Plastik	11.000	5.842	3.2	5.615	25	5.385
Kopi Robusta Mantap	12.000	5.835	3.2	5.615	30	6.385
Kopi Robusta + Jahe "9"	14.000	10.527	3.2	9.925	15	4.075
Kopi Jawara "9"	5.000	4.091	3.2	3.765	12	1.235
Kopi Luwak "9"	130.000	70.387	1.6	61.125	5	68.875
Capacity		4.929.885	1,920		257	
Overhead cost calculation per day			a. Salaries of the employees packaging (2)			50.000
			b. Salary of employee delivery (2 persons)			48.529
			c. Machine maintenance costs (LPG, etc.) (IDR)			15.000
			d. Electricity cost (IDR)			4,67
			e. Transportation costs (IDR)			26.000
						139.534
			Package (gram)	Cost prod (IDR)/ packaging/g		Total (IDR)
Calc. of capital raw materials per unit	Kopi Caffe Dos		150	60,41		9.061,25
	Kopi Krisna "9"		150	37,08		5.561,25
	Kopi Aroma "9"		200	40,38		8.075
	Kopi Robusta "9" A1		200	31,83		6.365
	Kopi Robusta Plastik		200	28,08		5.615
	Kopi Robusta Mantap		200	28,08		5.615
	Kopi Robusta + Jahe "9"		200	49,63		9.925
	Kopi Jawara "9"		200	18,83		3.765
	Kopi Luwak "9"		100	61,25		61.125
Capital raw materials per day (IDR)						115,107.50
Overhead cost calculations (IDR)						
Kopi Caffe Dos						83
Kopi Krisna "9"						337
Kopi Aroma "9"						489
Kopi Robusta "9" A1						309
Kopi Robusta Plastik						227
Kopi Robusta Mantap						220
Kopi Robusta + Jahe "9"						602
Kopi Jawara "9"						326
Kopi Luwak "9"						9.262
Kopi Arabika			Kopi Caffe Dos			$133 \times 150 = 20.000$
Kopi Robusta			Kopi Krisna "9"			$20 \times 150 = 3.000$
			Kopi Aroma "9"			$20 \times 200 = 4.000$
			Kopi Robusta "9" A1			$25 \times 200 = 5.000$
			Kopi Robusta Plastik			$30 \times 200 = 6.000$
			Kopi Robusta Mantap			$31 \times 200 = 6.200$
			Kopi Robusta + Jahe "9"			$20 \times 200 = 4.000$
			Kopi Jawara "9"			$14 \times 200 = 2.800$
Kopi Arabika Luwak			Kopi Luwak "9"			$8.00 \times 100 = 800$
Calculation of capital remaining production (IDR)						
Kopi Arabika						The capital of raw materials remain = $22.000 - 20.000 = 2.000$ $2.000 \times 60,408 = 120.817$
Kopi Robusta						The capital of raw materials remain = $5.000 - 3.000 = 2.000$ $2.000 \times 37,08 = 74,150$
						The capital of raw materials remain = $6.500 - 4.000 = 2.500$ $2.500 \times 40,38 = 100.938$
						The capital of raw materials remain = $7.600 - 5.000 = 2.600$ $2.600 \times 31,83 = 82.745$
						The capital of raw materials remain = $7.000 - 6.000 = 1.000$ $1.000 \times 28,08 = 28.075$
						The capital of raw materials remain = $6.500 - 6.200 = 300$ $300 \times 28,08 = 8.423$
						The capital of raw materials remain = $8.000 - 4.000 = 4.000$ $4.000 \times 49,63 = 198.500$
						The capital of raw materials remain = $8.600 - 2.800 = 5.800$ $5.800 \times 18,83 = 109.185$

Table III. Continued.

Calculation of capital remaining production (IDR)		
Kopi Arabika Luwak		The capital of raw materials remain = 3.000 – 800 = 2.200 2.200 × 611,25 = 1.344.750
Total capital of raw materials remain (IDR)		2.067.582
Ability of capital provision	Kopi Caffe Dos	133 unit × 9.144 = 1.219.178
	Kopi Krisna "9"	20 unit × 5.898 = 117.966
	Kopi Aroma "9"	20 unit × 8.564 = 171.289
	Kopi Robusta "9" A1	25 unit × 6.674 = 166.841
	Kopi Robusta Plastik	30 unit × 5.842 = 175.257
	Kopi Robusta Mantap	31 unit × 5.835 = 180.872
	Kopi Robusta + Jahe "9"	20 unit × 10.527 = 210.531
	Kopi Jawara "9"	14 unit × 4.091 = 57.274
	Kopi Luwak "9"	8 unit × 70.387 = 563.096
	Total capital of raw materials remain = 2.067.582	
	Ability of capital provision	4.929.885

Table IV. Optimal product mix after adjustment.

Product	Before adjustment	After adjustment
Kopi Caffe Dos	120	133
Kopi Krisna "9"	15	20
Kopi Aroma "9"	15	20
Kopi Robusta "9" A1	20	25
Kopi Robusta Plastik	25	30
Kopi Robusta Mantap	30	31
Kopi Robusta + Jahe "9"	15	20
Kopi Jawara "9"	12	14
Kopi Luwak "9"	5	8
Optimal value (Z)		2.783.758 IDR

application of other operations research (for example in forecasting and inventory levels), would be of great value to the organization. Nevertheless, for the practitioners, there is still much to be gained by adopting 'best practices' even though the implementation obstacles remain substantial.<sup>11</sup>

Information and Communication Technologies (ICT) adoption is often a barrier to SMEs in running their organizations. Lack of ICTs skills and knowledge is more evident in small- and medium-sized enterprises (SMEs).<sup>12</sup> However, some studies show that the impact of ICT utilization will be further strengthened when combined with other complementary investments such as training, decentralized decision making, and total quality management.<sup>13</sup>

#### 4. CONCLUSION

There are opportunities to increase production capacity after calculation of resource use is more complete. This means that the production capacity of Kopi Sembilan is still able to meet market demand, with the optimum benefit of 2.783.758 IDR per day. The results showed that the calculation of resource utilization more thorough, the organization was able to see the existing capabilities within their own organizations. This is important because it relates to seize opportunities in potential markets. Exploiting

knowledge of Operations Research is very important to have for SMEs in setting strategy and policy. However, knowledge in other fields is also important for decision makers, so that further research can be directed to the conditions before the determination of the marketing mix that is about product forecasting. In addition, information and communication technologies (ICT) adoption, innovation, and knowledge management can be directed to the productivity and financial performance of SMEs.

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