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Analysis of the labor, capital and machine production factors on micro-scale apple juice production in Batu City

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Abstract-Production factor is a resource that used in process of creating or product adding value so it covers everything needed on production activities. The purpose of this study was to determine effect of production factors i.e. labor, capital and machine technology on micro scale of apple juice production in Batu City. Fuzzy Analytical Hierarchy Process (FAHP) method will be used to determine the most affect factors on apple juice production activities. FAHP method is used in this study because it is suitable with complex problems on production activities and reduces the subjectivity of experts in determining the relationship between the factors of production studied. This research was conducted at the micro scale apple juice business which is still operating in Batu City and uses 4 experts who are the apple juice owners. The results of the study shows that the most affect production factors are capital (0.46), labor (0.32) and machine technology (0.22), while the sub-criteria which affect production factors are quantity of capital needed (0.2254), financial management performed (0.1553), labor productivity (0.1040), machine capacity (0.1001), labor development activities (0.0816), sources of capital (0.0794), labor competency (0.0736), machine sophistication level (0.0605), quantity of machine (0.0594) and quantity of labor (0.0592).

1. Introduction

The production process is a set of activities for creation of goods or services [1]. Production is the end result of the economic activity process by utilizing several inputs [2]. Through this understanding, it can be understood that the production activities are combining various inputs to produce output. The production process can occur if the production factors are available. Production factors are everything needed to produce goods or services. The production factor usually consists of several resources such as human resources (labor), sources of raw materials, capital resources and equipment machinery [3].

Labor is every person who is able to do work to produce goods and/or services both to meet their own needs or community needs [4]. Labor is one of the important factors in the production process because production activities do not only rely on the use of facilities with technology but still require labors to execute the production process [5]. The next production factor is capital, where is capital is funds used in the production process only, not including the value of land and buildings occupied or commonly called the working capital [6]. The amount of capital owned, will greatly affect productivity because more working capital makes a business able to provide adequate raw materials and other production factors [7]. Machine and technology is one of factor on production process scope



that is important for the ease of production activities. A machine is a tool in the process of transforming input into output so that the machine plays an important role in the processing process because the production process is not efficient and not optimal without the machine [8].

Based on data [9], it can be seen that Batu City is a city in East Java that produces the highest number of apples and provides the largest contribution to the national scale of apple production. In 2015, the apple production in East Java was 238,141 tons and in 2016 was increased to 329,066 tons. Seeing the high potential production of apples in Batu City, it caused many apple-based food products are developed in Batu City. One of the products made by apple which is well-known is apple juice. The apple juice from Batu City, East Java is one type of fruit juice that is well-known in the community and is a typical gift of the city.

This study will use Fuzzy Analytical Hierarchy Process (FAHP) method to reduce the subjectivity of the factor assessment and can simplify the complex production problems [10, 11]. The purpose of this study was to determine effect of production factors i.e. labor, capital and machine technology on micro scale of apple juice production in Batu City. This research is necessary to do because through this research, the business owners can prioritize production factor according to their influence to increase their business.

2. Materials and Methods

2.1. Sampling methods

Determination of the number of samples is limited to the Small Medium Enterprises (SMEs) of apple juice that are still operating, with the labors of 3-5 people, the production capacity is 500-600 cups/production with a volume of 120 ml. Through these criteria, 4 SMEs were obtained. The SME owned by individuals/entities with a maximum net worth of IDR 50,000,000.00 excluding the land and buildings and maximum annual sales of IDR 300,000,000.00 [12].

The main research facility is a questionnaire intended for apple juice SME owners who are considered experts. This questionnaire uses the membership function of the linguistic scale which gives the naming to a group that represents certain conditions in an easily understood language [13]. Linguistic Scale uses the Triangular Fuzzy Number (TFN) with each membership function defined by 3 parameters: the lower point (l), the midpoint (m) and the upper point (u) at the interval where the function is defined [14]. The linguistic scale used in this study can be seen in Table 1.

Table 1. Linguistic scale of FAHP.

AHP Scale Preference	F-AHP Linguistic Scale	Fuzzy Scale	Invers Fuzzy Scale
1	Equally preferred; equal preference	(1,1,3)	(1/3,1/1,1/1)
3	Moderately preferred; weak preference of one over other	(1,3,5)	(1/5,1/3,1/1)
5	Strongly preferred; essential or strong preference	(3,5,7)	(1/7,1/5,1/3)
7	Very strongly preferred; demonstrated preference	(5,7,9)	(1/9,1/7,1/5)
9	Extremely preferred; absolute preference	(7,9,9)	(1/9,1/9,1/7)
2	Intermediate values between 1 and 3 judgments	(1,2,4)	(1/4,1/2,1/1)
4	Intermediate values between 3 and 5 judgments	(2,4,6)	(1/6,1/4,1/2)
6	Intermediate values between 5 and 7 judgments	(4,6,8)	(1/8,1/6,1/4)
8	Intermediate values between 7 and 9 judgments	(6,8,9)	(1/9,1/8,1/6)

Source: Chuang and Liu [15] and Anshori [16]

2.2. Data analysis techniques

Stages in the research using the FAHP are divided into 2 stages, namely data analysis with AHP and then combined with Fuzzy [17]. The final result calculation of AHP is the calculation of CR, and if the CR value is $\leq 10\%$ then the pairwise comparison matrix is consistent. After that, the analysis continued by combining Fuzzy on the AHP using the rating of TFN according to Lai [18]; Ho et al. [19]; Rostamzadeh et al. [20]; Adnyana et al. [21] as follows:

1. Compiling the Fuzzy Pairwise Comparison Matrix
2. Calculating the value of Fuzzy Synthetic Extent
 - a. Calculating Fuzzy Synthetic Extent with the formula:

$$S_i = \sum_{j=1}^m M_i^j \times \frac{1}{\sum_{i=1}^n \sum_{j=1}^m M_i^j} \quad (1)$$

Where:

M = object (criteria and subcriteria),

i = row i,

j = column j,

l = lower value,

m = medium value,

u = upper value.

3. Calculating the Comparison of Likelihood of Fuzzy Numbers

After obtaining the Fuzzy Synthetic Extent value, then the probability level is compared. If the results obtained in each fuzzy matrix is $M_2 \geq M_1$ with $(M_2 = (l_2, m_2, u_2))$ and $(M_1 = (l_1, m_1, u_1))$ then the vector value can be formulated as follows :

$$V(M_2 \geq M_1) = \begin{cases} 1 & \text{if } m_2 \geq m_1, \\ 0 & \text{if } l_2 \geq \mu_2, \\ \frac{l_2 - \mu_2}{(m_2 - \mu_2) - (m_1 - l_1)} & \text{etc.} \end{cases} \quad (2)$$

4. Taking the Minimum Value of *Fuzzy Synthetic Extent*

5. Normalize the weight of the vector

This process is called defuzzification. This is a process which transforms fuzzy numbers into actual forms that are crisp or real. The following is the formula for normalizing the weight vector:

$$d(A_i) = \frac{d_1(A_i)}{\sum_{i=1}^n d_i(A_i)} \quad (3)$$

6. Calculating the aggregate values

7. Calculating the global values and ranks

The global values are obtained from the aggregate value of the sub-factor multiplied by the aggregate value of the main factor. Through this global value, it will be ranked sequentially.

3. Results and Discussion

This research was conducted on 4 SMEs that actively produce apple juice in Batu City. The SMEs were selected as respondents in the study because they were in accordance with the predetermined characteristics. The four SMEs include *Lucky Sari*, *Nanda*, *Gama Agro Nusantara*, and *Da'arus Sa'adah*. The data analysis which begins with the calculation of Analytic Hierarchy Process (AHP) shows that all CI and CR values on the main and sub-criteria/criteria are below 0.10 indicating the matrix consistency. According to Padmowati [22] the pairwise comparisons matrix that has been consistent, this means that all elements used have been homogeneously grouped and the relationships between criteria are justified and logical. After the consistent conditions are met, and then proceed by combining Fuzzy with AHP.

Data analysis using the FAHP was also carried out on the sub-criteria. The first criterion in this study is the criteria of labor which has 4 sub-criteria compilers including the quantity of labor (A1), labor competency (A2), labor productivity (A3) and labor development activities (A4). The second criterion is capital criterion which has 3 sub-criteria compilers including the quantity of capital needed

(B1), source of capital to run the business (B2) and financial management performed (B3). The third criterion is the technical criteria for machine technology, which has 3 sub-criteria compilers including quantity of machines used (C1), machine capacity (C2) and machine sophistication level (C3).

The data analysis was continued by calculating the aggregate value of the main criteria, the aggregate value of the sub-criteria. Based on the results of the aggregate values calculation on the main criteria and sub-criteria, FAHP hierarchy structure can be made on apple juice production factors which can be seen in Figure 1 below.

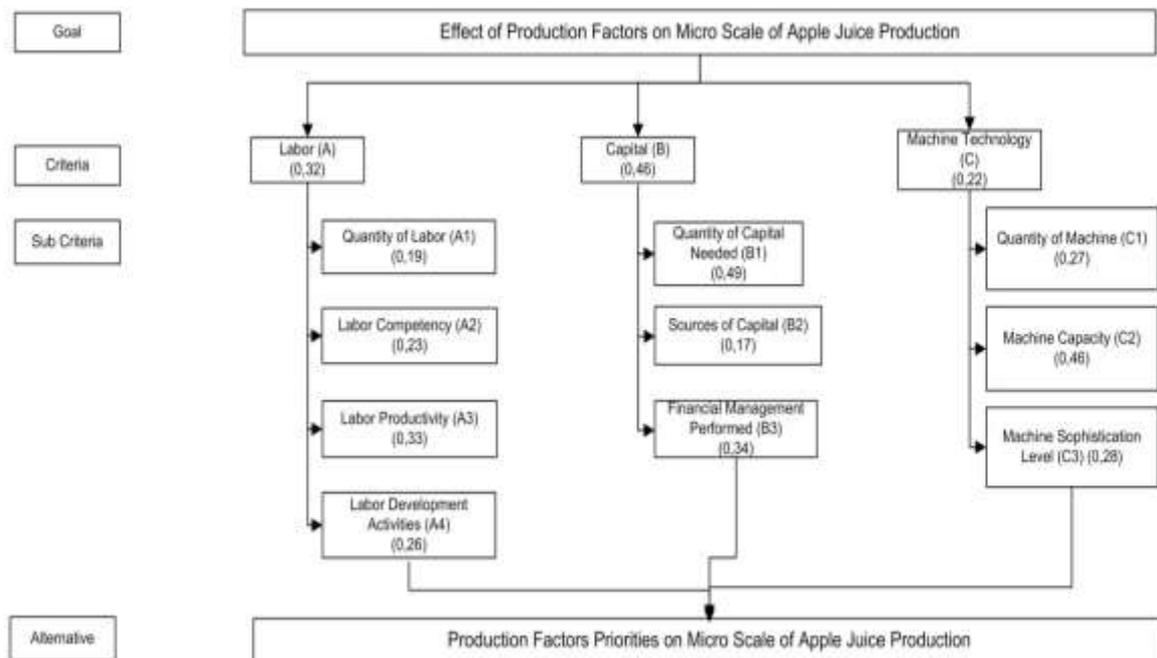


Figure 1. FAHP structure on production factors micro scale apple juice.

From Figure 1, it can be seen that the aggregate value of the capital factor has the largest value of 0.46 which means the experts consider the influence of capital factors in the apple juice production system in Batu City by 46%. The results of this study are in accordance with the literature revealed by Herjanto [23] that capital is the dominant factor that influences the sustainability of a business because the capital will be related to the costs that an effort can incur to run the production process. In addition, the greater the capital owned by a business, the better it will be for the business [24]. The labor factor has an aggregate value of 0.32 which means the experts consider the influence of the criteria of labor in the apple juice production system in Batu City by 32%. The results of interviews conducted by researchers to SME owners also show that the experts in this study prefer experienced labors to work in their SMEs so they do not need to be trained again. The last factor with the lowest aggregate value is machine and technology that is equal to 0.22, which means that experts consider the influence of the technical criteria for machinery and equipment in the apple juice production system in Batu City only by 22%. Tools and machines are one of the existing technologies and are useful as a tool to carry out the process of input transformation into the output.

Furthermore, the global value can be calculated and ranking can be done where the sub-criteria that have the highest ranking are the sub-criteria that influence the production factors the most in the micro-scale of apple juice production. In Table 2 below, you can see the calculation results of global values, ranking and sub-criteria.

Table 2. Result of global value and rank.

Criteria	Aggregate value of Criteria	Sub Criteria	Aggregate value of Sub Criteria	Global Value	Rank
Labor (A)	0.32	Quantity of labor (A1)	0.19	0.0592	10
		Labor competency (A2)	0.23	0.0736	7
		Labor productivity (A3)	0.33	0.1040	3
		Labor development activities (A4)	0.26	0.0816	5
Capital(B)	0.46	Quantity of capital needed (B1)	0.49	0.2254	1
		Sources of capital (B2)	0.17	0.0794	6
		Financial management performed (B3)	0.34	0.1553	2
Machine Technology (C)	0.22	Quantity of machine (C1)	0.27	0.0594	9
		Machine capacity (C2)	0.46	0.1001	4
		Machine sophistication level (C3)	0.28	0.0605	8

Source: Primary Data (2018)

Sub-criteria for quantity of capital needed (B1) are sub-criteria in the first rank with the highest global value of 0.49. Besides, this sub-criterion also has the highest sub-criteria aggregate value of 0.2254. This shows the importance of the capital quantity in determining the sustainability and development of a business. The capital used in this study is working capital. According to Suharyadi [25], working capital is capital that must be spent to buy or process products so that capital will be needed for the company's operations every day. Sub-criteria which rank second with a global value of 0.1553 namely financial management management. According to Rahmana [26], financial management is an important factor in a business because the amount of capital or profits owned by a business will be useless if it is not balanced with good financial management. Sub-criteria that rank third with a global value of 0.1040, namely labor productivity. Through interviews conducted with Apple juice owners, it can be seen that to keep labor productivity in Apple juice SME can be maintained by employing labors who have experience in the process of making Apple juice, so the owners focus on their experience, not their last education.

4. Conclusion

The most affect production factors are capital (0.46), labor (0.32) and machine technology (0.22), while the sub-criteria which affect production factors are quantity of capital needed (0.22), financial management performed (0.15), labor productivity (0.10), machine capacity (0.10), labor development activities (0.08), sources of capital (0.07), labor competency (0.07), machine sophistication level (0.06), quantity of machine (0.05) and quantity of labor (0.05).

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