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Analytical hierarchy process in determining the location of the cascara industry in *Aceh Tengah* District

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Abstract. Choosing the right industry location is an important thing in the business planning process. Cascara industry is one of activity that produces a new product of coffee tree such as a pulp coffee berry. This Industry has the potential to be developed. Processing waste pulp coffee cascara products such as cascara tea is expected to add higher value to pulp coffee. Building the new cascara industry in Aceh Tengah District needs a good strategy to choose the right location for the industry. One method that can be used to analyse this aspect is the method *Analytical Hierarchy Process* (AHP). Determination of the location of the cascara industry in Aceh Tengah District uses several criteria, namely the potential for cascara production, human resources, transportation access, and infrastructure availability. While the alternative locations chosen for the establishments of the cascara industry are Bebesen Sub district, Kebayakan Sub district, and Pegasing Sub district. According to the result of research, the best alternative location of raw material and infrastructure availability for the establishment of the cascara industry is Pegasing Sub districts with the weight of around 0.399.

1. Introduction

Aceh province is included as the fourth largest coffee producer in Indonesia. Coffee plantations in Aceh are quite large, with an area of 125,331 ha and producing 72,652 tons of coffee in 2019 in Aceh [1]. Coffee consists of two main types, namely Arabica and Robusta. One of Indonesia's top Arabica coffee-producing regions is the Gayo Highlands in Aceh Tengah District, with a total Arabica production of 34,609 tons in 2019. According to Saisa and Syabriana [2], coffee waste, such as pulp of coffee berry, is produced around 35-40% of coffee processing. From the outside to the inside, the coffee berry is made up of skin (exocarp part), pulp (mesocarp part), mucilage, parchment, silver skin (endocarp part), and coffee bean (endosperm) [3]. Unfortunately, the coffee pulp has not been utilized to its full potential thus far. Some farmers have utilized a little amount of the pulp directly as a natural fertilizer [4]. Many researchers have investigated the content contained in pulp coffee.

One of the products that can be processed from pulp coffee is cascara tea. Cascara tea, also known as coffee cherry tea, is created from coffee pulp, which is high in bioactive compounds such as polyphenol, which has good antioxidant effects, as well as carbohydrate, soluble fibre, mineral, and



protein, all of which are good for your health [5]. In a summary, this product can be developed. Cascara tea is made by sorting the coffee cherries (red fruit) and separating the coffee bean and skin. The next process is the coffee skin is dried until it is in accordance with the Indonesian national standard (SNI) for dry tea. The coffee skin is infused with hot water during the preparation, and the product is known as coffee cherry tea or cascara [6]. According to Arpi *et.al* [3] Cascara is a coffee-flavoured beverage with tea-like qualities.

The industry is an activity that involves converting raw materials into semi-finished or finished goods with a higher value than the raw materials. An industry's activities range from building design to supply chain management, product processing, and product distribution to customers [7]. Cascara industry is one of the industries that have the potential for development. The value of coffee pulp will rise as a result of the process of turning it into cascara tea. By using existing resources, the existence of industrial development is expected to improve the regional economy. Determining the location is one of the important stages when planning the establishment of an industry.

According to Susilowati and Hidayatullah [8], there are several criteria that must be assessed to determine the strategic location of an industry : (1) source of raw materials, availability of raw materials is very important for the smooth production process. The distance between raw materials and industry should not be too far, because it is feared that something will happen that can hinder the supply of raw materials. (2) Human resources, the presence of labour can also affect the smoothness of the production process. (3) Transportation access because industrial activities definitely require transportation to pick up raw materials and distribute products. (4) Energy Sources, industrial establishments require a lot of energy. Energy (electricity, gas, petroleum and others) needed to run machinery and equipment in the production process. (5) Market, the distance between the industrial location and the market is also an important thing to consider. That's because the market is a means to market the products that have been made. (6) Technology, use of appropriate technology, can reduce the impact of pollution generated by industry. In addition, technology can also take into account all aspects to improve the entire system in the industry. (7) Environmental conditions, industrial development must also study the environmental conditions around the industry. Unsafe environmental conditions, limited water sources, inappropriate climate and others can hamper all production activities.

Choosing the right industry location can make the company able to compete with other companies. An industry that works efficiently and effectively can determine the survival of the industry. Therefore, the strategy of determining the location of the business is an important thing in the business planning process. One method that can be used to analyse this aspect is the method Analytical Hierarchy Process (AHP).

AHP is a problem-solving method that starts with a thorough definition of the problem and then organizes it into a hierarchy with several levels or stages, such as goal level, criteria, and alternatives. Following the creation of the hierarchy, numerical values are assigned to subjective considerations of the degree of preference between elements at each hierarchical level [9]. Planning, determining alternatives, setting priorities, selecting policies, resource allocation, determining needs, forecasting needs, performance planning, optimization, and resolving objective and subjective conflicts are examples of factors that can be analysed using this method [10]. The most significant characteristic of AHP is its ability to logically combine knowledge, experience, individual viewpoints, and foresights. AHP offers a wide range of applications and has been successfully utilized to tackle a variety of decision support challenges, including facility layout design, supplier selection, quality control, and information technology outsourcing decisions [11]. The advantage of using the AHP method to determine industrial locations based on expert opinion is that it is a systematic method and arranges problems in a hierarchical form, using comparisons between criteria and alternatives, thus facilitating analysis and decision-making on problems [12].

2. Material and methods

Interviews with experts in their fields, observation, and documentation were used to collect all qualitative and quantitative data for this research. Secondary data will be obtained from various relevant journal articles and supporting documents to supplement this data. This data collection is carried out in order to obtain information that will be used to solve all problems and be taken into account when making decisions. Determination of the location of the cascara industry uses four criteria, namely the raw material availability, human resources, transportation access, and infrastructure availability. While the alternative locations chosen for the establishments of the cascara industry are Bebesen sub.district, Kebayakan sub.district, and Pegasing sub.district. The three alternative locations were chosen based on the agricultural status identification as places with the potential for raw material supply human resources, transportation access, and infrastructure availability.

Expert practitioners, government, and academics are personal experts or respondents who provide opinions on determining the location for the establishment of the cascara industry in Aceh Tengah District. One of the most widely utilized methods is the Analytical Hierarchy Process (AHP) method. It is used to assist in decision-making in practically all disciplines and circumstances. AHP method can be used to process data from expert respondent. However, in its application, the assessment of alternative criteria is carried out by several multidisciplinary experts (groups) [13]. The weight of the assessment for group assessments is expressed by finding the geometric mean (Geometric Mean) of the assessments given by all group members. The data collected from experts using the AHP method will be analysed in Microsoft Excel.

The paired assessment results obtained from the experts will be calculated on a geometric average with the following formula:

$$GM = \sqrt[n]{(X1), (X2), \dots (Xn)} \quad (1)$$

Where:

GM = Geometric Mean
 x1 = The First Expert
 xn = The Last Expert
 n = Number of experts

Steps for analysing the problem using AHP method [14]:

- (1) To define and specify the problems,
- (2) Backfill all elements of the problems we have detailed a hierarchy form,

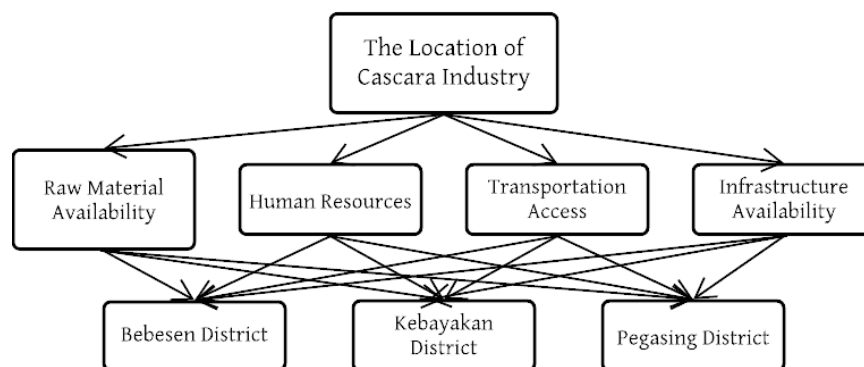


Figure 1. Analytical Hierarchy Process (AHP) hierarchical structure chart.

- (3) Make a matrix of pairwise comparisons to see the influence between elements that are relevant to each criterion that is one level above,

Table 1. Matrix of pairwise comparisons between elements.

	Atribut B			
Atribut A	Raw Material Availability	Human Resources	Transportation Access	Infrastructure Availability
Raw Material Availability	1			
Human Resources		1		
Transportation Access			1	
Infrastructure Availability				1

And compare each criterion to the alternative

Table 2. Matrix of pairwise comparisons between alternative locations.

	Atribut B		
Atribut A	Bebesen District	Kebayakan District	Pegasing District
Bebesen Sub district	1		
Kebayakan Sub district		1	
Pegasing Sub district			1

(4) Calculation of Eigen Vector (Xi) Values,

(5) Test the priority and consistency (consistency index and consistency ratio) of the elements,

$$CI = \frac{\lambda_{max} - n}{n - 1} \quad (2)$$

n = number of criteria

$$CR = \frac{CI}{RI} \leq 0,1 \quad (3)$$

(6) If the data is consistent with evidenced by the CR value ≤ 0.1 then the data can be used for ranking to make decisions on the alternatives you want to know.

3. Results and discussion

Several criteria for determining the cascara industry, including raw material availability, human resources, transportation access, and infrastructure availability, were compared using a comparison table and the AHP method. The comparison results were analysed in order to identify a strategic location for the establishment of the cascara industry in the Aceh Tengah District.

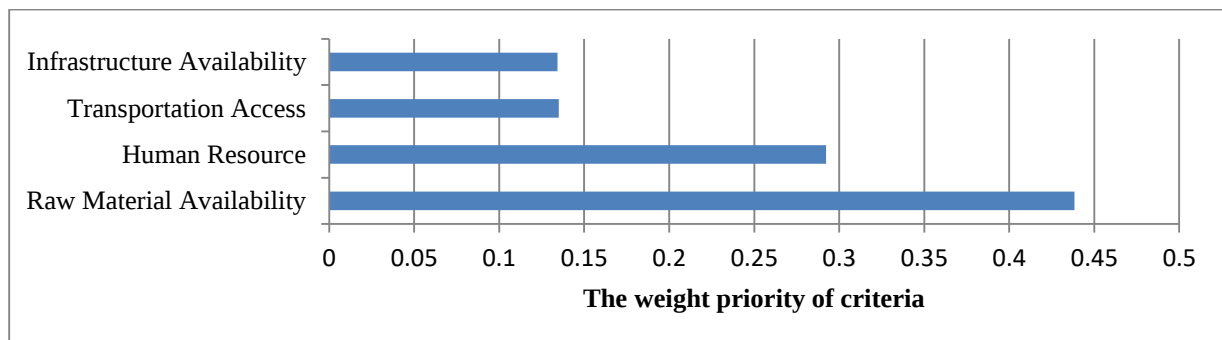


Figure 2. Criteria for establishment cascara industry.

The comparison data criteria provided by the expert have been tested for consistency and get a consistency ratio (CR) of 0.015. According to the findings of the research, the availability of raw materials is the most important criterion. Raw materials are the most important thing that an industry must own. Human resources are the second most important criterion for establishing an industry. This is due to the fact that all activities in the industry, from raw material processing to office workers, are performed by humans. Meanwhile, infrastructure availability and transportation accessibility have similar priority weights.

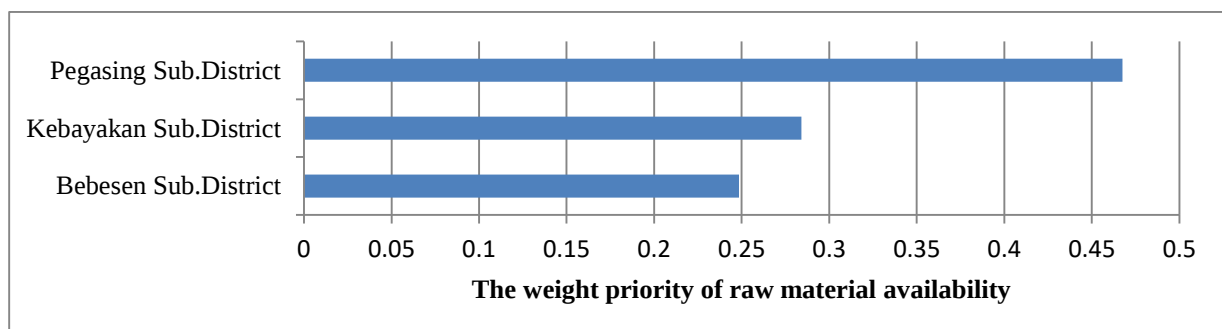


Figure 3. Alternative location based on raw material availability.

The consistency of the comparison data alternative location based on raw material availability provided by the expert was examined, and a consistency ratio (CR) of 0.008 was obtained. Pegasing sub-district is a regional location that has the highest weight in terms of raw material availability with the weight 0.467. According to BPS [15] data are and production coffee from Aceh Tengah District, With a plantation size of 4346 hectares and a production of 3128.3 tons of coffee, Pegasing sub-district has the largest coffee plantation in comparison to other sub-districts. Meanwhile, the coffee plantations in Kebayakan sub-district are slightly larger than those in Bebesen sub-district. This also explains why the Pegasing sub-district has a higher raw material potential than the other sub-districts.

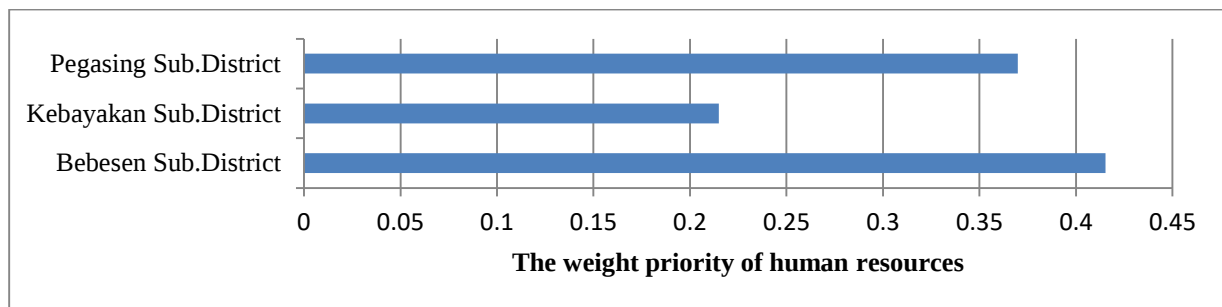


Figure 4. Alternative location based on human resources.

The consistency ratio (CR) of 0.08 was obtained after evaluating the comparison data alternative location based on human resources provided by the expert. Human resource criteria include the criteria needed to establish an industry. Human resources are assessed based on quantitative (community population) and qualitative (community education and work). According to experts, Bebesen sub-district is an alternative location based on human resources with the weight 0.415, because this area has the largest population compared to other alternative locations. Data from BPS [15] state, that population in Bebesen Sub district is about 41010 people. While, the population of the Pegasing and Kebayakan sub-districts is 22733 and 17900 people respectively. According to data Bebesen sub-district in figures [16] as many as 199 residents work in the coffee industry.

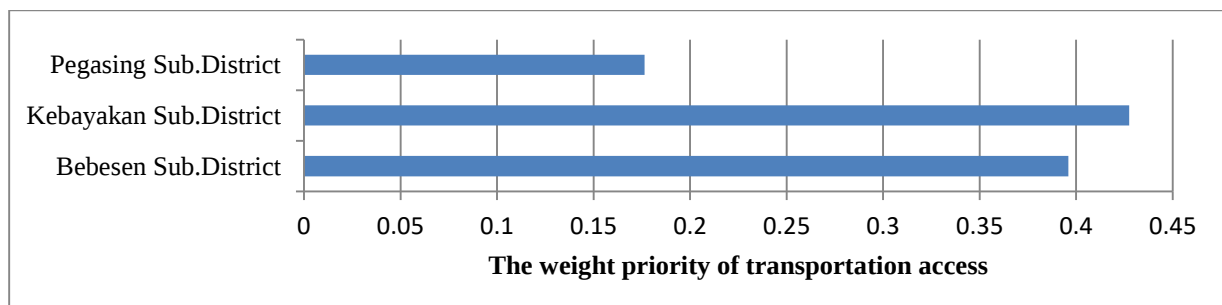


Figure 5. Alternative location based on transportation access.

The consistency of the comparative data alternative location based on transportation access provided by the expert was evaluated, and a consistency ratio (CR) of 0.005 was obtained. Transportation access criteria in Kebayakan Sub district (weight = 0.427) become an alternative location that is prioritized by experts. This is because most of the coffee plantations in the area are easily accessible and the plantations are located on the edge of the highway. Bebesen sub-district and Pegasing sub-district have good transportation access, but there are some coffee plantation areas that are difficult to reach.

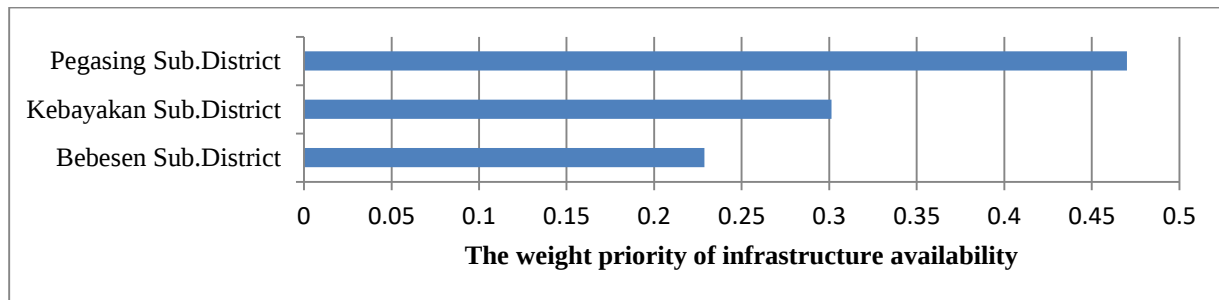


Figure 6. Alternative location based on infrastructure availability.

The comparison data alternative location based on infrastructure availability provided by the expert has been evaluated for consistency and gets a consistency ratio (CR) of 0.007. Infrastructure availability is one of the important things to examine. The infrastructure in question is the existence of equipment or machinery, sufficient water and electricity. Pegasing Sub district was chosen as the best alternative location based on the availability of infrastructure with the weight is 0.470. This is supported by the presence of 20 coffee sector industries in Pegasing Sub district [17].

Table 3. Location alternative ranking.

	Raw material availability	Human resources	Transportation access	Infrastructure availability	Priority Ranking	Ranking
Bebesen Sub district	0.249	0.415	0.396	0.229	0.315	2
Kebayakan Sub district	0.284	0.215	0.428	0.301	0.286	3
Pegasing Sub district	0.467	0.370	0.176	0.470	0.400	1

4. Conclusions

According to the results of the weighting of the alternative locations against all of the criteria, the alternative location with the highest weight for the establishment of the cascara industry is Pegasing Sub district, with a weight of 0.399. Data processing in Microsoft Excel shows that all data provided by experts is consistent, because $CR \leq 0.1$.

References

- [1] Direktorat Jenderal Perkebunan 2021 Statistik Perkebunan Unggulan Nasional *Angew. Chemie Int. Ed.* 6(11), 951–952.
- [2] Saisa and Syabriana M 2018 Produksi Bioetanol Dari Limbah Kulit Kopi Menggunakan enzim *Serambi Eng.* **III** 271–8
- [3] Arpi N, Muzaifa M, Sulaiman M., Andini R and Kesuma S. 2021 Chemical Characteristics of Cascara, Coffee Cherry Tea, Made of Various Coffee Pulp Treatments *Int. Conf. Sustain. Agric. Food Energy* **709** 1–8
- [4] Murlida E, Noviasari S, Nilda C, Rohaya S, Rahmi F and Muzaifa M 2021 Chemical characteristics of cascara tea from several varieties of coffee in Aceh Province Chemical characteristics of cascara tea from several varieties of coffee in Aceh Province *Int. Conf. Agric. Bio-industry* **667** 1–7
- [5] Komaria N, Suratno, Prihatin J and Sudarti 2020 An analysis of innovation on the utilization of cascara by coffee farmers *J. Phys. Conf. Ser.* **1563**
- [6] Klingel T, Kremer J I, Gottstein V and Rezende T R De 2020 A Review of Coffee By-

- Products Including Leaf , *Foods* **9** 1–20
- [7] Sofyan A, Poerwati T, Hari W and Widodo S 2012 *Penentuan Alternatif Lokasi Industri Perikanan di Wilayah Pengembangan Sumbermanjing Wetan- Kabupaten Malang* (ITN Malang)
 - [8] Susilowati T and Hidayatulloh M F 2019 Metode Analytical Hierarchy Process (AHP) dalam Penentuan Lokasi Home Industry di Kabupaten Pringsewu *J. Manaj. Sist. Inf. dan Teknol.* **9**
 - [9] Kholilah, Azis S and Iskandar T 2017 Analytical Hierarchy Process (AHP) to Determine Location Priority Scale for Bridge Widening at Lawang-Malang Road , Indonesia *Int. J. Sci. Technol. Res.* **6** 190–5
 - [10] Sulistiyani E, Amir M I H, K.R Y, Nasrullah and Injarwanto D 2017 Implementasi Metode Analytical Hierarchy Process (AHP) Sebagai Solusi Alternatif Dalam Pemilihan Supplier Bahan Baku Apel Di PT . Mannasatria Kusumajaya *Jechnology Sci. Eng. J.* **1** 87–101
 - [11] De Felice F and Petrillo A 2010 A new multicriteria methodology based on analytic hierarchy process: The “expert” AHP *Int. J. Manag. Sci. Eng. Manag.* **5** 439–45
 - [12] Permatasari C K 2020 Penerapan Analitical Hierarchy Process (Ahp) dalam Menentukan Lokasi Pabrik Tempe *J. Appl. Sci.* **2** 024–33
 - [13] Sael N, Hamim T and Benabbou F 2019 Implementation of the Analytic Hierarchy Process for student profile analysis *Int. J. Emerg. Technol. Learn.* **14** 78–93
 - [14] Rimantho D, Fathurohman F, Cahyadi B and Sodikun S 2017 Pemilihan Supplier Rubber Parts Dengan Metode Analytical Hierarchy Process Di PT.XYZ *J. Rekayasa Sist. Ind.* **6** 93
 - [15] Badan Pusat Statistik 2021 *Kabupaten Aceh Tengah Dalam Angka 2021* (Badan Pusat Statistik)
 - [16] Badan Pusat Statistik 2020 *Kecamatan Bebesen Dalam Angka 2020* (Badan Pusat Statistik)
 - [17] Badan Pusat Statistik 2020 *Kecamatan Pegasing Dalam Angka 2020* (Badan Pusat Statistik)