

Original Article

Analytical hierarchy process (AHP) in Expert Choice for determining superior plantation commodities: A case in East Kolaka Regency, Indonesia

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Abstract

This study aims to determine eminent commodity plantations in East Kolaka, Indonesia, with consideration criteria leading the commodities to include cocoa, coffee, coconut, and palm oil as alternatives. The method used is analytical hierarchy process (AHP) based on *Expert Choice 11 software*. The AHP is a method of decision-making on the problem of determining priority options from various alternatives. The use of AHP begins by creating a hierarchical structure of the problem to be studied. The pairwise comparison matrix is used to form relationships in the structure. In the pairwise comparison matrix, the weight of each criterion is sought by normalizing the pairwise comparison matrix. The maximum eigenvalues and normalized eigenvectors will be obtained from the matrix. In the process of determining the hierarchical weighting factor as well as the evaluation factor, a consistency test must be carried out with $CR < 0.100$. The relative weighing of selection criteria was: eligible for business development (EBD) 26.7%, contribution to community income (CCI) 18.0%, value-added (VA) 13.3%, local government policy (LGP) 11.0%, land suitability (LS) 10.5%, market orientation (MO) 10.7%, and 9.7% towards environmentally-friendly (TEF) criteria. The relative selection rates of the leading commodities in East Kolaka Regency, were cocoa (52.7%), oil palm (18.6%), coconut (13.9%), and coffee (14.7%).

Keywords: Expert Choice 11, analytical hierarchy process, leading plantation commodities

1. Introduction

The agricultural industry is an essential aspect of the Indonesian economy, particularly for its further development. The agriculture sector has enormous development potential in numerous areas (Herdhiansyah & Asriani, 2018; Herdhiansyah, Sutiarto, Purwadi, & Taryono, 2012). Furthermore, the agricultural sector has proven to be dependable in the recovery of the national economy, as evidenced by the farm sector's ability to contribute to the

national economy in the Gross Domestic Product (GDP) revenue, and by its role during the pandemic crisis. Plantation growth is one of the ways in which a thriving sector can play a vital role in economic development, helping people. According to Hermawati, Suwanto, and Octaviany, (2014), this subsector provides more than 19.4 million jobs to the Indonesian population. The estate sub-sector has also significantly increased the country's foreign exchange activity. A plantation is an effort to use dry land by planting certain commodities. Based on plants, the plantations can be divided into annual plantations, such as tobacco and sugarcane plantations, and perennial plantations, such as oil palm, rubber, cocoa, coffee, clove and clove plantations. The function of plantations according to the Plantation Law

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includes three things: the economic process, namely increasing prosperity, people's welfare, and strengthening regional and national economic structures. Second, the ecological function is to increase soil and water conservation, carbon sink, oxygen supply, and buffer protected areas. Third, the social function of cultivation is to improve the nation's unity (Hasnudi, & Iskandar Sembiring, 2010). However, with the development of globalization in each region, the current government encourages community activities to develop businesses based on excellence or local potential wisdom in each area. The characteristics of the number of regional advantages are the fulfillment (quantity) quality and the expected processed materials. They have market value and selling value to develop economic added value from the resources managed by each region (Herdhiansyah, Kariasti, Rianda, & Asriani, 2020).

Determination of national and regional superior products is the first step towards development based on efficiency to gain comparative advantage and competitive advantage. In the face of trade globalization, it is necessary to take a regional development approach based on potential. Development policies related to regional development cannot exist in general without looking at the potential for biodiversity, but they must pay attention to the specifics of the area to be developed to be appropriately implemented, right on target and real. The plantation sector is still a mainstay for increasing the regional income of Southeast Sulawesi Province. Therefore, a touch of policy for regional agricultural development is needed to improve the welfare of farmers.

In general, East Kolaka Regency is an area with varied climate and land conditions. The diversity of physical properties of this land can be used as a basic asset in making considerations that determine the zoning of agricultural commodities. The physical land characteristics will determine the types of commodities that can be cultivated and will affect the level of productivity. Agricultural development planning, which is based on zoning, will be able to overcome competition between regions. The method of solving problems begins with identifying the existence of several needs for such operation of the system that is considered effective, one approach using a decision support system based on the AHP (Analytical hierarchy process) method. The analytical hierarchy process (AHP) is a method of measurement through pairwise comparisons, which relies on expert judgment to get a priority scale (Arundaa, 2016; Fitriyani, & Yanuarti, 2019; Saaty, 2008). It has become one of the most widely used standards of decision-making (Ahmad, 2018; Rani, & Sakthivel, 2015; Vaidya, & Kumar, 2006). It is used by decision-makers and researchers because it is such a simple and powerful approach (Amalia, Elok, & Anisa, 2019; Aprilia & Triase, 2017; Jefri, Ester, & Parapat, 2014; Syafrianto, 2016; Umar, Sunardi, & Yasinta, 2017). This method was developed to find a systematic practice for prioritizing and supporting complex decisions. In fact, the hierarchical structure of the AHP method can measure and integrate many factors of a complex decision-making process hierarchically, making it easy to combine various parts into one (Falatehan, 2016; Leal, 2020; Marimin & Maghfiroh, 2010; Susilowati, & Hidayatulloh, 2019).

The analytical hierarchy process (AHP) decision support model was developed by Thomas L. Saaty. This model will transcribe a complex multi-factor or multi-criteria

problem into a hierarchy. According to Amalia, Elok, and Anisa (2019), Umar, Abdul, and Yuminah, (2018), hierarchy is defined as a representation of a problematic situation in a multi-level structure where the first level is the goal, followed by the factor level, criteria, sub-criteria, and so on down to the last level, the alternative considerations for developing weights or priorities. A software program that is used to solve problems based on AHP is *Expert Choice 11* that supports *collaborative* decisions with a hardware system that facilitates group *consensus of decisions*. In general, making that is more efficient, analytical, and allows real-time reactions from the management team to identify the influencing factors and criteria. However, these are also called aspect (Huang, Chu, & Chiang, 2008), attribute (Hsu, Lee, & Kreng, 2010), class (Rezaei, Fahim, & Tavasszy, 2014), dimension (Yang, Chuang, & Huang, 2009), index (Rostamzadeh & Sofian, 2011), and perspective (Bentes, Carneiro, da Silva, & Kimura, 2012).

Development and increase in the production of plantation crop commodities needs to be directed and determined by the characteristics of each region. Choosing a prominent entity in an area is the first step in agricultural development based on efficiency, to gain a comparative competitive advantage in facing the global market. It is hoped that the regional development based on superior commodities will spur growth in that area and increase people's incomes. Utilization of the potential of fine and potential sites in an optimal and integrated manner is a prerequisite that needs to be considered so that the welfare and prosperity of society can be achieved. So, this is what encourages the author to submit a study on only plantation commodities in East Kolaka Regency using the AHP (Analytical hierarchy process) method as a comparative and structured decision-making model.

2. Materials and Methods

2.1 Data collection identification

To find out the types of data needed, research on superior plantation commodities was carried out by observations, interviews, and questionnaire stages in East Kolaka Regency, as summarized in **Table 1**.

Table 1 identifies the types of research data collection needs for only plantation commodities in East Kolaka Regency, namely: (1) Government data needed for the area of East Kolaka Regency, population, and livelihoods; (2) Traders and banking data needs whether the data are related to the cooperation pattern of plantation *share profiles* and plantation capital lending; (3) Academics additional knowledge seen from perspective of the potential for plantation development knowledge; (4) Association of Farmer Groups (GAPOKTAN) data needs on plantation land area, land conversion, harvest area, pest and disease attacks, and productivity; and (5) Central Bureau of Statistics (BPS) of East Kolaka Regency data needs on type of dry land area, and the amount of data related to plantation commodities *Update*.

2.2 Expert Choice 11 software consistency ratio (CR) model validation testing

The AHP method is also a qualitative approach that is very popular in decision-making based on expert judgment,

Table 1. Identification of data to collect on leading plantation commodities in East Kolaka

No.	Source type of data needs	Variable	Unit
1.	Government (Plantation Service, Trade, Industry, Cooperative, Small and Medium Enterprises (PPKUKM) Service and Agriculture Office	The area of East Kolaka Regency	Hectares
		Population	Soul
		Livelihood	Ton / Year
		Profit share	
2.	Traders and banking	Plantation products and farmer capital loans	Ton / Year
3.	Academics	Agricultural and plantation knowledge guide	
4.	Association of Farmer Groups (GAPOKTAN)	Plantation area	
		Harvest area	
		Transfer of land functions	
		Pest and disease attack	
		Productivity	
5.	Pusan Statistics Agency East Kolaka Regency	Dry land area for plantation	Hectares
		Amount of data related to plantation commodities update	

seeking consistency by experts. In this method, a pairwise comparison matrix is formed first from the comparative estimates of each related expert, to achieve the scale preference of these factors (and their respective attributes), which are given in terms of normalized weights between 0 and 1. In this case, the validity of each provision that was determined required a consistency ratio (CR) <0.10, and these were included in further analysis. The determination of the consistency of the matrix itself is based on the *maximum eigenvalue*. The Consistency Ratio (CR) test results consisted of 5 selected respondents. The level of respondent selection was based on the relationship that had sufficient knowledge regarding only plantation commodities in East Kolaka Regency, which be seen in **Table 2**.

Table 2. Consistency ratio (CR) test results in Expert Choice 11 software

Respondent	Consistency Ratio (CR)
1. Department of Agriculture	0.06
2. Head of plantation	0.05
3. Merchants	0.06
4. GAPOKTAN	0.05
5. Trade, industry, small and medium enterprises office.	0.04
6. Banking	0.02
7. Academics	0.06

3. Results and Discussion

3.1 Matrix pairwise comparison between criteria and each alternative against each of the plantation commodity criteria in East Kolaka Regency

The comparisons were choices or judgments by decision-makers assessing the importance of an element compared to the other elements. Pairwise comparison between criteria in Expert Choice 11 software is illustrated in Figure 1 below.

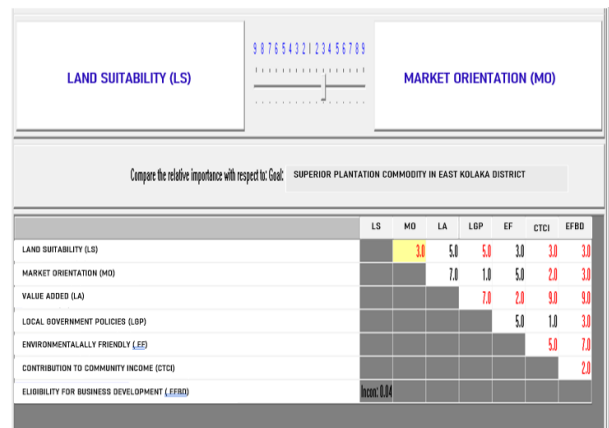


Figure 1. Pairwise comparisons between criteria in Expert Choice 11 software

3.2 Normalizing the pairwise comparison matrix

The result of p, there is a pairwise comparison matrix, the weight of each criterion is sought by normalizing the pairwise comparison matrix, and the normalization weighting can be seen in Figure 2 below.

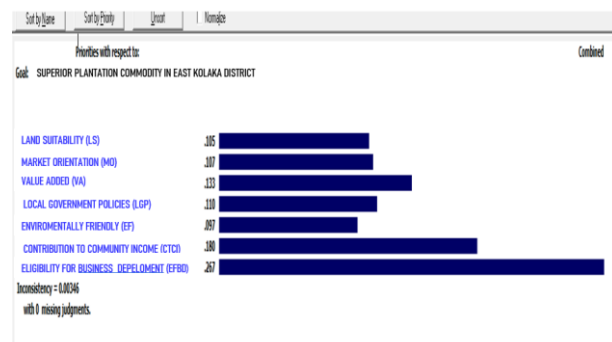


Figure 2. Pairwise comparison matrix of normalized weighted sums

3.3 Data analysis

The results of the calculation of the weight factor of all alternatives for each criterion were prepared according to the AHP method, including the weighting of the criteria. To weigh each priority, an analytical hierarchy process was used with a questionnaire composed of a) Objectives, b) Procedure to fill in following the priority, and c) Table on comparison of each indicator (Anucharn, & Dasananda, 2017). After calculating the weight factors of all alternatives for each criterion, the evaluation factor for all alternatives is obtained. From all evaluations carried out on the 7 criteria, a table of relationships between criteria and alternatives was obtained seen in Figure 3 below.

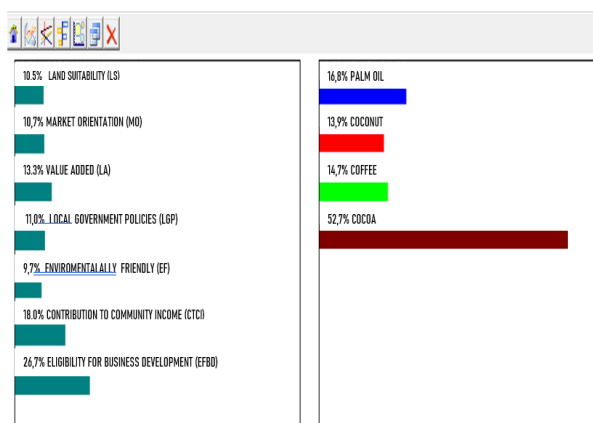


Figure 3. *Dynamic performance of goal: plantation commodities in East Kolaka Regency*

Figure 3 shows that the weight factor calculation of all alternatives for each criterion was prepared according to the AHP method by *Expert Choice 11 software*, such as the weights given to oil palm (18.6%), coconut (13.9%), coffee (14.7%), and cocoa (52.7%) on the comparison criteria: Land Suitability (LS) (10.5 %), Market Orientation (MO) (10.7 %), Value Added (VA) (13.3 %), Cooperation of Regional Government (CRG) (11.0 %), Environmentally Friendly (EF) (9.7 %), Contribution to Community Income (CCI) (18.0 %), and the Eligibility for Business Development (EBD) (26.7 %). This means that the criteria in Eligible for Business Development (EBD) for determining the superior plantation commodity in East Kolaka Regency chose developing Cocoa with the percentage of selection (52.7 %), triggering the criteria for sharing Business Development with the highest weight, namely 0.267 or 26.7 %.

The cocoa production level is 397,790 Kg and has the largest land area among the commodities of 69,737 Ha. Coconut is a commodity on the second production level, namely 58,293 Kg, then coffee 2,356 Kg and oil palm 2,135 Kg. The area of coconut farm land is 2,355 ha, coffee is on 1,489 ha, and oil palm on 298 ha (Central Bureau of Statistics of East Kolaka Regency, 2020)

Based on the research of the UUP (Productive Business Unit) Tanjung Sari partnered with PT Bumi Tangerang on the added value of fermented cocoa, the purchase and sale of fermented cocoa can provide economic benefits with the added value of Rp. 2,638.3 / kg and a profit

rate of 28.79% (Indira, 2013). This shows that the cocoa commodity has added value worthy of business development. Eligible for Business Development (EBD) 0.267 (26.7%) is an influential criterion for recommendations for the development of plantation commodities in East Kolaka Regency and with the highest weight of 52.7% cocoa was the selected plantation commodity, important for export from Indonesia, and one contributor to the country's foreign exchange from the non-oil and gas sector. Indonesia is also the third-largest cocoa supplier, accounting for 13% of 3,290,000 tonnes per year of the world's current total demand for cocoa. This means that the Eligible criteria for Business Development (EBD) for determining the superior plantation commodity in East Kolaka Regency chooses the development of cocoa with a weight percentage (52.7 %) as a superior commodity, and its benefits have actually been felt in people's income, especially by farmers producing dry beans in East Kolaka Regency. Smallholders (KK): (1) cocoa farmers as many as 30,527; (2) 5,600 coconut farmers; (3) coffee as many as 2,043 farmers; and (4) oil palm as many as 248 farmers (BPS Kolaka Timur Regency, 2020).

4. Conclusions

The analytical hierarchy process (AHP) based on the Expert Choice 11 application defined a trigger for excellence in the plantation sector, with the selection criteria as a reference for developing commodity selection options in East Kolaka. The relative importances of criteria were as follows: business criteria (EBD) 26.7%, contribution to community income (CCI) 18.0%, value-added (VA) 13.3%, local government policy (LGP) 11.0%, land concessions (LS) 10.5%, market orientation (MO) 10.7%, and 9.7% towards environmentally friendly criteria (rl). The selection of superior commodities in East Kolaka Regency had the rank order cocoa (52.7%), oil palm (18.6%), coconut (13.9%), and coffee (14.7%).

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