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Research paper

FMADM for determining superior commodity at agroindustry area

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Abstract

Indonesia has many excellent commodities that are spread throughout Indonesia, especially in Lampung province. Lampung Province has excellent commodities, among others: coffee, rubber, oil palm, cocoa and coconut. To determine the superior commodity in Lampung province, a decision support model is needed to determine the superior commodities in the agroindustry. This study aimed to create a decision support model that can facilitate in determining the suitable and feasible priority of superior in agroindustry. The commodity is to be developed. The research was carried out by designing application that was developed by using computer programming language and applying the principle of system development by applying the best alternative decision-making method from certain criteria, namely Fuzzy Multiple Attribute Decision Making (FMADM). Fuzzy MADM is a method used to find optimal alternatives from a number of alternatives with certain criteria. This method was chosen because this method determines the weight for each attribute, followed by an alternative rating that will determine the superior commodity for agroindustry in Lampung Province based on the calculated weight using fuzzy formula to get more accurate results about the superior commodity in Lampung province.

Keywords: *Agroindustry; Decision Support System; Fuzzy Multiple Attribute Decision Making; Lampung Province.*

1. Introduction

1.1. Background

Regional development is a comprehensive and integrated program of all activities taking into account existing resources and contributing to the development of a region [1 - 4]. The concept of regional development is an effort to realize integrated use of resources with balancing and harmonizing development between regions, between sectors, and development actors in realizing regional development goals [5 - 8]. Lampung Province has the main potential in the plantation sector which contributes quite large [9 - 12].

The development of a strong and resilient agricultural sector needs to be supported by the industrial sector [13 - 16]. The agricultural industry also called agro-industry has an important role, namely increasing the added value of agricultural commodities, as a provider of productive employment, and as one of the country's foreign exchange [17 - 21]. The role of the agricultural sector is not only seen from the primary products produced, but must be linked to the manufacturing and marketing industries created and their role in attracting and encouraging development, especially in rural areas [22 - 26]. The agricultural sector is closely related to the processing industry [27 - 30]. The agricultural sector acts as a supplier of raw materials for processing industry activities [31 - 36].

Processing industry activities in Lampung Province become one of the three main sectors that contribute greatly to the Gross Regional Domestic Product (GRDP) of Lampung Province [37 - 40]. The number of the contribution of the industrial sector and processing of the GRDP of Lampung Province can be seen in Table 1.

Table 1: The Number of the Contribution of the Industrial Sector and Processing of the GRDP of Lampung Province

Business field	2006	2007	2008	2009	2010
Agriculture, livestock, forestry, and fishery	42.72	42.55	41.63	40.60	38.53
Mining and excavation	2.76	2.52	2.36	2.04	1.86
Processing industry	13.19	13.24	13.29	13.40	13.52
Electric, gas, and fresh water	0.35	0.36	0.35	0.34	0.38
Construction	4.95	4.92	4.90	4.89	4.79
Trading, hotel and restaurant	15.72	15.50	15.76	16.04	15.86
Transportation and communication	6.01	6.12	6.33	6.70	7.32
Finance, realestate and service company	6.66	7.23	7.82	8.41	10.18
Services	7.64	7.54	7.55	7.59	7.57

Table 1 shows that the processing sector in Lampung Province has a large contribution in GRDP. The processing sector in 2006-2010 continued to increase. This can prove that Lampung Province has a large enough prospect of developing agro-industry.

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Based on the table above shows that the field of business in the agricultural sector, livestock, forestry and fisheries from 2006-2010 is the largest number compared to other sectors, it is necessary to do business in determining superior commodities in agriculture, so as to increase the GDP of Lampung Province [41 - 45]. To facilitate the determination of superior commodities in the Lampung Province agroindustry, it is necessary to make a Decision Support model using the FMADM (Fuzzy Multiple Attribute Decision Making) method [46 - 50]. Because of the large number of commodities in Lampung Province, it is difficult to determine superior commodities in Lampung, thus making the researchers want to make a decision support system that can be used to determine the superior commodity by taking the title of research [51 - 55] "The Making of Decision Support Model Using FMADM For Determining Superior Commodity at Agroindustry Area In Lampung Province".

1.2. Problem formulation

Based on the description on the background of the above problems, the following problems can be formulated:

1) How to make a decision support model to determine superior commodities in the Lampung Province agro-industry area?
2) How to determine superior commodities by using decision support applications in Lampung Province?

1.3. Problem limitations

The problem limitations taken in this discussion are:

1) This Decision Support System is only a tool to determine the superior commodities in Lampung Province.
2) The method used in designing this system is Fuzzy Multiple Attribute Decision Making (FMADM).

1.4. Purpose of research

The purpose of this study was to design a software that can help in determining the superior commodities in the agricultural sector, plantations in Lampung Province.

1.5. Benefit of research

The benefit of this research is to help in making decisions to determine the superior commodities in the area of agro-industry in Lampung Province.

2. Literature review

2.1. Definition of decision support system

Decision Support System (DSS) is a computer-based system that is expected to help solve complex and unstructured and semi-structured problems [56 - 59]. Decision Support system is a combination of human and computers [60 - 63]. The Concept of Decision Support Systems was first revealed with the term Management Decision System [64 - 68]. Decision making that involves several of these criteria is called multi criteria decision making [69 - 71]. Multi criteria decision making is part of the problem of relatively complex decision making, which includes one or several decision makers, with a number of diverse criteria that must be considered, and each criterion has a certain weight value, with the aim of obtaining an optimal solution for a problem [72 - 75]. There are some purposes from decision support system namely:

1) Helping manager in making decision about semi structured problem.
2) Giving support on manager consideration and not aimed to change manager function.
3) Improving effectivity of decision taken by manager more than efficiency improvement.
4) Speed up the computing system on a computer so that it allows decision makers to do a lot of computing quickly with low costs.
5) Improvement of productivity in taking a decision.
6) Support of computer quality can improve decision quality made.

2.2. Fuzzy multiple attribute decision making (FMADM)

Fuzzy Multiple Attribute Decision Making (FMADM) is a method used to find optimal alternatives from a number of alternatives with certain criteria. The core of Fuzzy MADM is to determine the weight score for each attribute, then proceed with the ranking process that will select the alternatives that have been given [76 - 79]. Basically, there are 3 approaches weight score attribute, namely subjective approaches, objective approaches and integration approaches between subjective and objective.

Each approach has advantages and weakness. On subjectivity approach the weighting score is determined based on the subjectivity of the decision makers, so that several factors in the alternative ranking process can be determined freely [70 - 72]. Whereas in the objective approach, the weight value is calculated mathematically so that it ignores the subjectivity of the decision maker.

2.3. Agroindustry

According to the Director General of Processing and Marketing of Agricultural Products of the Ministry of Agriculture agro-industry is an industry that processes primary agricultural commodities into processed products, either intermediate products or finish products, including post-harvest handling, industrial food and beverage processing, biopharmaceutical industry, bio-energy industry, by-product processing industry and agro-tourism industry [60 - 63]. Agroindustry is an industry that gives added value to agricultural products in the broadest sense including marine products, forest products, livestock and fisheries [64 - 67]. Agribusiness is a series of activities involving input subsystems, production subsystems, processing subsystems (agroindustry), yield marketing subsystems and supporting sub-systems [68][69][70]. Agro-industry is an effort related to processing that involves processing, preserving, storing, and packing agricultural products, especially the results of coastal and marine aquaculture.

2.3.1. Principles of agroindustry

The need for the development of agro-industry in the rural area by taking into account the basic principles including:

1) Boost product/commodity competitive advantage and comparability in each region.
2) Encourage increased capacity of human resources and growing appropriately and agro industries that capable in the developed area.
3) Expand the area of superior commodity of agribusiness centers which will function as sustainable raw materials.
4) Spur the growth of regional agribusiness by presenting agribusiness subsystems.
5) Present various supporting facilities for the development of rural industries [65 - 67].

2.3.2. Agroindustry goals and objectives

The goal to be achieved in the development of rural agro-industry is to improve the welfare of rural communities through efforts to increase added value and competitiveness of agricultural products. To realize this goal, the development of rural agro-industry is directed to:

1) Develop industrial clusters, namely processing industries that are integrated with production centers for raw materials and supporting facilities.
2) Develop household and small scale processing industries which supported by medium and large scale processing industries.
3) Develop a processing industry that has high competitiveness to increase exports to meet domestic needs [4].

2.4. Lampung province

Lampung Province was present on March 18, 1964 with the enactment of Government Regulation Number 3/1964 which later became Law No. 14 of 1964. Before that Lampung Province was a Residency which was incorporated into the Province of South Sumatra.

Even though Lampung Province before 18 March 1964 was still administratively part of the Province of South Sumatra, this area, long before Indonesia had independence had indeed shown enormous potential and a distinctive cultural color that could add to the cultural customs of the beloved archipelago. Therefore, in the VOC era Lampung region was inseparable from the target of Dutch colonialism. The Lampung Provincial Plantation Service in 2013 targeted an increase in production and productivity of seven superior commodities including coffee and black pepper, especially for export targets.

3. Research method

3.1. Data collection

Central Bureau of Statistics of Lampung Province is an agency that provides information about commodity data produced from year to year, so that in the future the community can carry out agricultural development to

achieve good agricultural results to realize food self-sufficiency and increase the processing industry of raw materials into finished goods. To realize the development planning, information is needed in determining the superior commodities of Lampung Province. The techniques used in data collection include [80-100]:

a) Literature Method. Literature method is a data collection technique by studying references in the form of documents/files and collecting data, legislation, books, research journals etc. Through literature study, a study was conducted on superior commodities in Lampung Province. The need for data that reveals the indicators used by potential investors for investment decision making was obtained through literature study of research books and journals. Literature study was also conducted to determine the information technology capabilities that will be applied in the system.

b) Observation Method. Observation method is a research method where, the researcher observes / sees and examines directly to the object of research about all activities related to the purpose of the research, by analyzing and evaluating the current system and providing solutions through information systems to be developed so that it can be more useful.

c) Interview Method. The interview is a conversation between the researcher and the informant. The researcher hopes to get information, while the informant is someone who is assumed to have important information about an object, the interview was conducted directly to employees of the Central Bureau of Statistics of Lampung Province the community, and related agencies.

3.2. Implementation of FMADM method with SAW calculation

In this analysis, all data obtained from Lampung Province would be implemented in the form of decision making based on the FMADM method used. The steps are:

a) Determine each criterion as shown in table 2:

Table 2: Criteria Information

Criteria code	Criteria
C1	Availability level of selected commodity production
C2	Applied level of technology support in cultivation
C3	Productivity level
C4	Availability level of processing technology
C5	Market share of products

b) Furthermore, from each of these criteria the weight will be determined. At this weight consists of five numbers Fuzzy Multi Attribute Decision Making (FMADM).

3.3. Criteria weighting

Commodity data is important data or important elements in the decision support system for determining superior commodities in the agro-industry area.

The table 3 below is a data table of prospective borrowers who become the alternative choice or as a prospective customer who is feasible, prospective customers who become alternative choices marked with the letter A.

Table 3: Alternative Superior Commodities with A_1- A_5

No	Alternative	Commodity
1	A1	Coffee
2	A2	Rubber
3	A3	Oil palm
4	A4	Chocolate
5	A5	Coconut

Decision making in determining the weights for each criterion as shown in table 4.

Table 4: Weight of Criteria

Criteria code	Weight
C1	35%
C2	25%
C3	20%
C4	10%
C5	10%

Figure 1 shows weighting value.

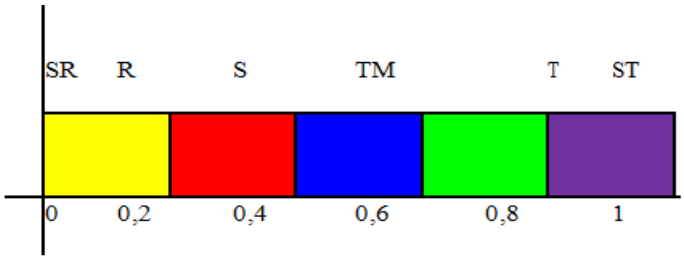

Fig. 1: Weighting Value.

Next step to determine compatibility rating as shown in table 5.

Table 5: Compatibility Rating

Alternative	Review result				
	C1	C2	C3	C4	C5
Coffee	0.5	0.6	0.4	0.8	0.7
Rubber	0.3	0.4	0.5	0.2	0.5
Oil palm	0.6	0.5	0.7	0.5	0.8
Cocoa	0.4	0.2	0.5	0.3	0.4
Coconut	0.2	0.3	0.5	0.4	0.6

Performing normalization from each alternative using following formula:

$$Rij = \begin{cases} \frac{Xij}{maxi\ (xij)} \\ \frac{Min\ i\ xij}{Xij} \end{cases}$$

Where:
If J is benefit attribute
If J is cost attribute
Then detail calculation for each component is as follows:

a) For availability level score of selected commodity production

R11 = 0.5/Max(0.5, 0.3, 0.6, 0.4, 0.2) = 0.5/0.6 = 0.8
R12 = 0.6/Max(0.6, 0.4, 0.5, 0.2, 0.3) = 0.6/0.6 = 1
R13 = 0.4/Max(0.4, 0.5, 0.7, 0.5, 0.5) = 0.4/0.7 = 0.5
R14 = 0.8/Max(0.8, 0.2, 0.5, 0.3, 0.4) = 0.8/0.8 = 1
R15 = 0.7/Max(0.7, 0.5, 0.8, 0.4, 0.6) = 0.7/0.8 = 0.9

b) For support level score of applied technology in cultivation

R21 = 0.3/Max(0.5, 0.3, 0.6, 0.4, 0.2) = 0.3/0.6 = 0.5
R22 = 0.4/Max(0.6, 0.4, 0.5, 0.2, 0.3) = 0.4/0.6 = 0.7
R23 = 0.5/Max(0.4, 0.5, 0.7, 0.5, 0.5) = 0.5/0.7 = 0.7
R24 = 0.2/Max(0.8, 0.2, 0.5, 0.3, 0.4) = 0.2/0.8 = 0.2
R25 = 0.5/Max(0.7, 0.5, 0.8, 0.4, 0.6) = 0.5/0.8 = 0.6

c) For productivity level score

R31 = 0.6/Max(0.5, 0.3, 0.6, 0.4, 0.2) = 0.6/0.6 = 1
R32 = 0.5/Max(0.6, 0.4, 0.5, 0.2, 0.3) = 0.5/0.6 = 0.8
R33 = 0.7/Max(0.4, 0.5, 0.7, 0.5, 0.5) = 0.7/0.7 = 1
R34 = 0.5/Max(0.8, 0.2, 0.5, 0.3, 0.4) = 0.5/0.8 = 0.6
R35 = 0.8/Max(0.7, 0.5, 0.8, 0.4, 0.6) = 0.8/0.8 = 1

d) For level score of processing technology availability

R41 = 0.4/Max(0.5, 0.3, 0.6, 0.4, 0.2) = 0.4/0.6 = 0.7
R42 = 0.2/Max(0.6, 0.4, 0.5, 0.2, 0.3) = 0.2/0.6 = 0.3
R43 = 0.5/Max(0.4, 0.5, 0.7, 0.5, 0.5) = 0.5/0.7 = 0.7
R44 = 0.3/Max(0.8, 0.2, 0.5, 0.3, 0.4) = 0.3/0.8 = 0.4
R45 = 0.4/Max(0.7, 0.5, 0.8, 0.4, 0.6) = 0.4/0.8 = 0.5

e) For product market segment score

R51 = 0.2/Max(0.5, 0.3, 0.6, 0.4, 0.2) = 0.2/0.6 = 0.3
R52 = 0.3/Max(0.6, 0.4, 0.5, 0.2, 0.3) = 0.3/0.6 = 0.5
R53 = 0.5/Max(0.4, 0.5, 0.7, 0.5, 0.5) = 0.5/0.7 = 0.7
R54 = 0.4/Max(0.8, 0.2, 0.5, 0.3, 0.4) = 0.4/0.8 = 0.5
R55 = 0.6/Max(0.7, 0.5, 0.8, 0.4, 0.6) = 0.6/0.8 = 0.7

From above calculation obtained normalized matrix as follows:

$$R = \begin{pmatrix} 0.8 & 1 & 0.5 & 1 & 0.9 \\ 0.5 & 0.7 & 0.7 & 0.2 & 0.6 \\ 1 & 0.8 & 1 & 0.6 & 1 \\ 0.7 & 0.3 & 0.7 & 0.4 & 0.5 \\ 0.3 & 0.5 & 0.7 & 0.5 & 0.7 \end{pmatrix}$$

Score to each criterion as follows:
W1= 35%, W2=25%, W3=20%, W4=10%, W5=10%
W= [0.35, 0.25, 0.2, 0.1, 0.1]
Then the ranking result of best score for each alternative (Vt) can be calculated by following formula :

$$V_i = \sum W_j R_{ij}$$

Then the result obtained was as follows:

V_1 = (0.35) (0.8) + (0.25) (1) + (0.2) (0.5) + (0.1) (1) + (0.1) (0.9)
= 0.28+0.25+0.1+0.1+0.09
= 0.82
V_2 = (0.35) (0.5) + (0.25) (0.7) + (0.2) (0.7) + (0.1) (0.2) + (0.1) (0.6)
= 0.17+0.2+0.1+0.02+0.06
= 0.55
V_3 = (0.35) (1) + (0.25) (0.8) + (0.2) (1) + (0.1) (0.6) + (0.1) (1)
= 0.35+0.2+0.2+0.06+0.1
= 0.91
V_4 = (0.35) (0.7) + (0.25) (0.3) + (0.2) (0.7) + (0.1) (0.4) + (0.1) (0.5)
= 0.2+0.07+0.1+0.04+0.05
= 0.46
V_5 = (0.35) (0.3) + (0.25) (0.5) + (0.2) (0.7) + (0.1) (0.5) + (0.1) (0.7)
= 0.1+0.1+0.1+0.05+0.07
= 0.42

Between V1, V2, V3, V4, V5 with the highest score was V3, so that the superior commodity in the agroindustry of Lampung province was V3 = oil palm with score of 0.91, the second commodity was V1 = Coffee with score of 0.82, the third superior commodity was V2 = rubber with score of 0.55 and fourth superior commodity was V4 = brown with score of 0.46 and fifth superior commodity was V5 = Coconut with score of 0.42.

4. Conclusion

After analyzing and direct observation to research object then researchers can conclude some conclusion namely: 1) Decision support model in determining superior commodity in agroindustry area in Lampung province used Fuzzy Multiple Attribute Decision Making (FMADM) with SAW for calculation. 2) Result in determining superior commodity in agroindustry area, Lampung Province using decision support model among others : V1, V2, V3, V4, V5 with the highest score was V3, So the superior commodity in Agroindustry areal, Lampung Province was V3 = oil palm with score of 0.91. Second commodity was V_1= Coffee with score of 0.82 and third superior commodity was V2 = rubber with score of 0.55, then fourth superior commodity was V4 = cocoa with score of 0.46 and fifth superior commodity was V5 = coconut with score of 0.42.
Because of creation process/decision support system there are some weakness and still far from perfection, some suggestions are proposed for next development among others: 1) To be tested the success rate of Fuzzy Multi Attribute Decision Making (FMADM) method must be done in several different areas with the criteria parameter score for each different alternative so that the success rate of this method can be calculated with the results in the field. 2) Next research must be done by integrating best product determination system from existing commodity so that it will be seen some suitable products that can be developed at selected commodity.

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