Original Research Paper

Assessing Potential Investment Return of Basil (*Ocimum Basillicum P.*) using Fuzzy Logic and Investment Analysis Criteria for Environmental-Based Agriculture

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Abstract: Indonesia is one of Southeast Asia's most populous and big countries. It was well-known for its richness of natural resources. Indonesia is one of the world's largest tropical countries, because of its tropical environment. According to the statistics, however, arable land in Indonesia has declined dramatically over the years in response to increased demand for residential areas. This data reveals a fairly alarming fact: It is feasible that, despite its wealth of natural resources, Indonesia could one day be unable to meet its domestic food demands. Furthermore, rivalry and obstacles faced by Indonesian farmers may exacerbate the country's restricted food supply. The assessments of potential investment in basil plant (*Ocimum basillicum P.*) were conducted, to support the agricultural innovation to be more appealing among stakeholders, researchers, and farmers. In assessing the potential investment, the financial aspect of the feasibility study is used in this study, where this assessment was commonly used in planning and forecasting the financial gains of a project or investment. The Decision Support Model (DSM) was using a fuzzy logic method in determining the investment decision. We hope this study will provide better analysis and accurate decisions for stakeholders, researchers, and farmers.

Keywords: DSM, Fuzzy Logic, Basil Plant, Hydroponic, Investment Analysis

Introduction

Indonesia is one of the most populated and large countries in Southeast Asia. Its abundance of natural resources was well known. Supported by its tropical climate, made Indonesia among the largest tropical nation in the world. However, according to the data, arable land in Indonesia has drastically decreased over the years along with the rising demand for residency areas. This statistic shows a rather concerning fact that it is possible that even though Indonesia, along with its richness of natural resources, would one day unable to fulfill its own domestic food needs. Moreover, competition and hindrances experienced by the Indonesian farmers might also worsen this limited food supply. The assessments of potential investment in basil plant (*Ocimum basillicum P.*) were conducted, to support the agricultural innovation to be more appealing among stakeholders, researchers, and farmers. In assessing the potential investment, the financial aspect of the feasibility study is used in this study, where this assessment was commonly used in planning and forecasting the financial gains of a project or investment. The Decision Support Model (DSM) was using a fuzzy logic method in determining the investment decision. We hope this study will provide better analysis and accurate decisions for stakeholders, researchers, and farmers.

According to data provided by the Indonesian Ministry of Agriculture (Pertanian, 2019), data on productive land in Indonesia from 2014 to 2019 continued to decline by 4.6%. from the previous 2015 of having a productive land area of 8.1 million hectares. In 2019 it decreased to 7.1 million hectares of land. And this figure continues to decrease along with population growth in Indonesia. Where since 2015 Java, one of the most densely populated provinces in Indonesia been inhabited by 145 million people, and in

2020 that number continues to increase to 152 million people (Gischa, 2021).

This condition is not good. As the food demand is still rising, in line with population growth. Moreover, the various challenges faced by Indonesian farmers are challenging, and many; of them are harvested crops that cannot reach the end customer optimally. Other causes include crop failure, climate change, declining purchasing power as a result of the pandemic, market price volatility, high distribution costs, etc. (Setya, 2020). This imbalance of supply and demand has led to a decreasing interest of farmers to cultivate crops. The high cost of shipping also makes it difficult for big cities to reach the harvested areas where crop demand was high.

In several countries, solutions to deal with various problems in agriculture have been implemented. The innovations offered and quite popular as an agricultural technique happened in the Netherlands, which has implemented artificial fields (greenhouses) that use climate control technology on each farmland. With a country territory inhabited by an estimated 3.500 inhabitants per km^2 (square kilometer), the Netherlands has become the second-largest export capacity of vegetables and fruits and only below that of America which has a land area of 270 times larger than the Netherlands (Viviano, 2017).

With this accomplishment in a developed country such as the Netherlands. Indonesia with a larger portion of farmlands and territory supported by its tropical climate could achieve a more promising food producer worldwide if the research development on agricultural technologies is furtherly under government support. The application of greenhouse, there are also various applications. However, the majority still implement hydroponic techniques and other growing media supported by artificial light to manipulate sunlight according to the needs of each plant, while the rest are other supporting technologies such as roofs of greenhouses that use solar panels, and sensors for regulating water, air, and light. With the Internet of Things (IoT) technology is integrated to form an artificial climate, as well as the concept of multilevel layers or so-called vertical farming (Shamshiri *et al*., 2018).

To make this kind of innovation in agricultural technologies to be more appealing to future shareholders to invest in this sector, some analytical approach to predict the potential profits and risk needs to be assessed. In assessing this financial projection, this study adopts Decision Support Model in assessing those investment returns to gain a more accurate decision. This method has also been used before in another study by using fuzzy logic as its main method. Such as (Elysia and Utama, 2020) who use this DSM method to determine the most optimal decision in determining the planning of a product cycle. Some apply the fuzzy logic technique as a decision-making system in determining the most appropriate supplier. Several types of fuzzy are used for decision making, among others, fuzzy-AHP (Analytical Hierarchy), fuzzy-TOPSIS (Technique for Order Preferences by Similarity to Ideal Solution), and fuzzy Multi-Objective Linear Programming (MOLP) (Gunawan *et al*., 2018). Still, another research that applies fuzzy logic in evaluating suppliers in supply chain management such as (Kumar *et al*., 2013) uses Mamdani fuzzy inference system. Other research involves qualitative methods, such as research that interviewed dozens of experienced textile industry executives. Then, a Multi-Input Single-Output (MISO) Mamdani fuzzy inference system was applied to this survey results for evaluation by taking the nine most important factors, as opined by the respondents to reach a final decision. There are other studies related to the medical sector that use this DSM as a decision-making method in dealing with hospital wastes so that this decision-making becomes an environmental-based Decision-Making (eco-DSM) (Utama *et al*., 2018). DSM that involves fuzzy logic could also save lives, as conducted by (Wadgaonkar and Bhole, 2017) to minimize human error factors in deciding which anesthesia practice will be infused into the patient. This life-threatening decision will be implemented using fuzzy logic to avoid propofol being infused wrongly. Various parameters such as heart rate, oxygen saturation, and blood pressure are continuously monitored using a developed GUI application. Whereas (Abou *et al*., 2011), uses fuzzy-based DSM for guiding doctors to assess the risk stratification of breast cancer. By using input variables such as Her_2, hormone receptors, age, tumor grade, tumor size and lymph node, and risk status as its output variable. The system uses the Mamdani inference system and is applied in MATLAB for its simulation.

Furthermore, some studies implement fuzzy logic in managing investments as our study intended to do. One of them is (Casanova, 2012) who applies fuzzy logic in managing investment portfolios. The Decision Support System developed refers to regulations in managing stock portfolios as well as a fuzzy inference system in selecting shares to be purchased and managed.

Jankova *et al*. (2021) research also deal with market volatility, especially in the Exchanged-Traded Fund (ETF) market by using fuzzy logic type-2. This type-2 fuzzy logic works with three-dimensional fuzzy sets that can provide a more dynamic perspective on the model and allow the model to be able to process numerical and linguistic uncertainties directly. Research (Boloş *et al*., 2019) also discusses investment decision-making involving fuzzy logic. However, apart from the previous DSM related to investment which discusses deeply market volatility, this research lies in its application in deciding which company to acquire. Meanwhile, DSM in the agricultural sector, (Gandhi *et al*., 2016) research has developed software that can predict the yield produced by rice plants during harvest season on provided parameter inputs. Parameters such as precipitation, climatic conditions, soil, farmers, fertilizers, herbicides, pesticides, and soil quality. So that growth can be reviewed and even used in various horticultural techniques to increase growth productivity.

Research Object

Basil Plant

The basil plant (*Ocimum Basillium P.*) was selected as a research object of this study; as it is economical, short-lived (Cahyani, 2014), perfectly fit for plant modeling (Peter, 2012), and has plenty of benefits concerning this pandemic situation (Cahyani, 2014). It is defined as a short-age plant; thus, for PCM propose, it can be easily studied to model the plant from its seedling period until its harvests period. Another fact about the Basil plant, it is stated that the distillation process of Basil leaves, contains antibacterial substances that could eradicate *S. aureus* and *E. coli* with a Minimum Bactericidal Concentration (MBC) of 0.5 and 0.25%v/v respectively. It implies that Basil plants can be used as raw material for non-alcohol hand sanitizer products, so it is hoped that it can replace the use of alcohol-based hand sanitizer which was commonly used (Cahyani, 2014). With basil-based hand sanitizer, the production cost comparison could end up cheaper than alcohol-based hand sanitizer. That this study was arranged during the COVID-19 pandemic, where the impact of the virus has widely impacted and claimed the lives of approximately 1.5 million people (Ritchie *et al*., 2020) the moment when this report was written. Thus, various socialization regarding the importance of hand hygiene in preventing the chain of spread has become one of the main priorities.

Materials and Methods

Investment Analysis

Investment in general terms is an asset or object that is purchased with the hope that in the future it will generate income or added value from that relying asset or object. In the case of agriculture, it means that the main resources related to farming such as seeds, planting media, nutrients, etc., are expected to produce promising profitability. To achieve a result on whether the investment is profitable, this study will use the financial aspect of feasibility which was commonly used in planning and forecasting the financial gains of a project (Jakfar and Kashmir, 2012). The formula for calculating the financial aspect includes terms such as Return on Investment (RoI), Net Present Value (NPV), Benefit/Cost Ratio (BCR), and Payback Period (PP). Mentioned terms followed by their description and equation will be explained in Table 1.

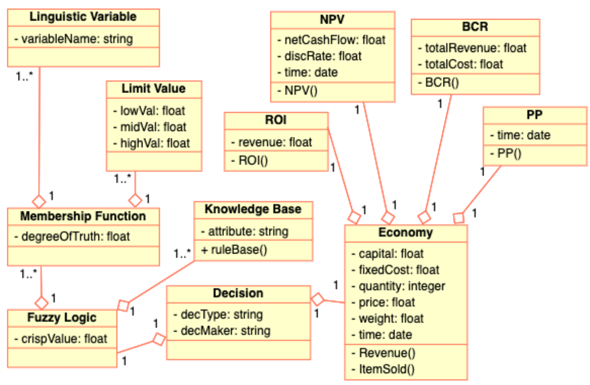

Fig. 1: Class diagram of decision support model

Table 1. Investment analysis terms and equation

	Terms	Description	Equation	
1	Return on Investment (ROI)	Return on investment is calculated based on the division of the income generated by the amount of capital invested	$ROI = \frac{(Revenue - Capital)}{Capital} \times 100\%$	(1)
2	Net Present Value (NPV)	The difference between the present value of cash inflows and the present value of cash outflows over some time	$NPV = \frac{R_t}{(1+i)^t}$	(2)
			R_t = Net cash flow at time t i = Discount Rate t = Time of the cash flow	
3	Payback Period (PP)	The amount of time it takes to recover the cost of an investment	$PP = \frac{Capital}{Average\,Cash\,Flow\,during\,time}$	(3)
4	Benefit-Cost Ratio (BCR)	The ratio used in a cost-benefit analysis to summarize the overall relationship between the relative costs and benefits of a proposed project	$BCR = \frac{Total\,Benefit}{Total\,Cost}$	(4)

Table 2: Average weight of plants consecutively over 3 times plantation cycles

Plant label	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	Average
Cycle 7 Weight (g)	8	11,4	13	14	8,7	16,6	16,1	13,7	5,1	3,6	5,7	-	10,54

Class Diagram

To have a better illustration for the generated GroIMP model to work, we provide a model based on Unified Model Language (UML) using the class diagram. This model is a construction model of an object where we do not have sufficient knowledge about the characteristics and knowledge that involves direct observation which is difficult to grasp. This model is broadly a process of building an illustration of how the object is being constructed in this study (Shirzad *et al*., 2021). The selection of a class diagram as a modeling method is adjusted for fuzzy logic in assessing potential profit through investment analysis criteria.

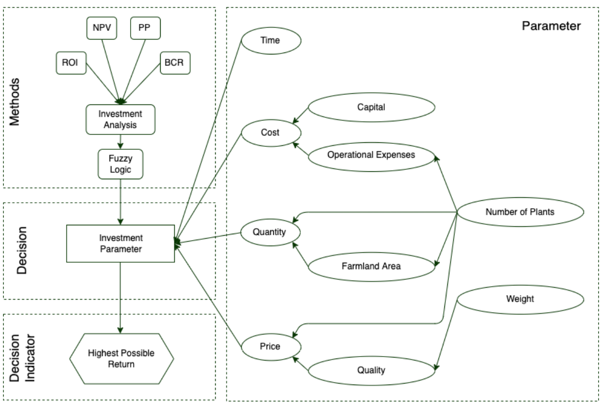

Fig. 2: Influence diagram of decision support model involving investment analysis criteria

Influence Diagram

The decision process involves several other parameters that support the end decision results. Influence Diagram depicts a graphical representation of those parameters as nodes that represents the range of decision alternatives if those alternatives are represented by a connected node that is dependent solely on each other. Each arrow that points out any nodes represents sequencing. Everything before each decision presented as nodes need to be resolved before moving out to other nodes. Most importantly, any proper Influence diagram cannot have any loops on each node or in its entirety. As pictured in Fig. 2, a parameter such as time, cost, quantity, and the price was the main parameter that could, later on, be assessed as a decision model. Implementing fuzzy logic and a calculation of metrics such as ROI, NPV, PP, and BCR which are commonly used as an assessment method in the financial aspect of feasibility study in the hope to get a more accurate decision result.

Results and Discussion

The plant dataset to be used in this study was planted in the researcher's backyard with a hydroponic wick system horticulture technique. The data was collected during the cultivation process which was commonly around 60 days period for Basil plants (*Ocimum basillicum*) (Cahyani, 2014), and at the end of the planting period, the plant average weight was gathered as purposed for the model input parameter. Other information related to growth supporting equipment and tools such as hydroponic system, nutrients, growth medium, seed, etc., was collected generally through an e-commerce site available within the Indonesia market region. Those e-commerce sites available are Tokopedia, Shopee, Blibli and Bukalapak. The preferred product price collected will be the cheapest one possible among mentioned sites. Harvested crop data were collected and the average weight of it and price of each component that supports the plant's growth along the process respectively are shown in Tables 2 to 4.

Any risk related to crop failure (i.e., first and second failed attempt of plantation) will be excluded from Table 2. Considering that quantifying risks of an investment would require another research study that comprehensively covers analysis and projection of any occurrence of risk contingency. As above-mentioned that our empirical data consist of over 3 times of planting cycle. This happens because of various crop failures during this plantation and could only achieve harvesting day of 3 over 7 times planting attempt, Average weight on each cycle reached an average of 9 g. This average weight is then going to be the main weight reference for the fuzzy logic DSM. But eventually, this research will only exhibit the last plantation weight, since the DSM uses the last plantation average weight as a parameter in reaching its final decision.

Table 3: Initial capital of the plantation investment according to the lower component price per plant

Hydroponic technique	Quantity	Price/plant	Total price
Wick system	9	1.665,56 IDR	14.990 IDR

Table 4: Fixed cost of the plantation investment

Item	Quantity /plant	Quantity available	Cost/item	Total cost
Seeds	1	400	18 IDR	7.200 IDR
Nutrients (ml)	3,64	10000	56,056 IDR	154.000 IDR
Netpot	1	1	150 IDR	150.000 IDR
Rockwool (cm^2)	15,63	480000	22,62 IDR	695.000 IDR

The initial capital of the item shown in Tables 3 and 4. will not be measured in the next cycle of the planting period (if any), since this item will be reused in every planting cycle until a replacement is necessary. The determined price for the initial capital item that will be used in this study will remain constant and was chosen based on the lower price per plant ratio to achieve a more promising investment result. These fixed cost items are shown in Table 4 and will be repeatedly measured in the next planting cycle if necessary until the investment has reached its break-even point and for basil plant sell price, we have classified the price also based on any price range also within the previously mentioned e-commerce sites.

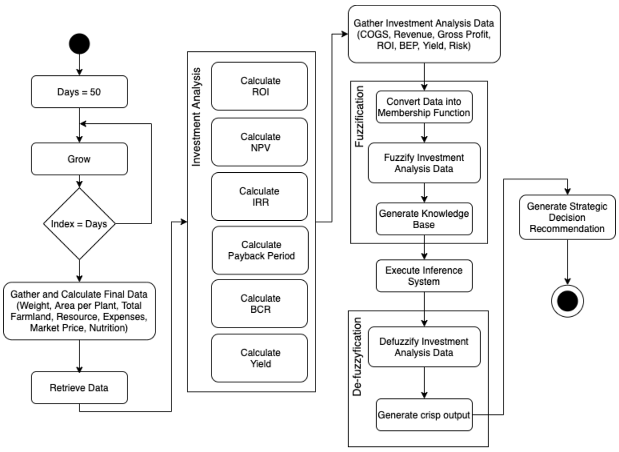

Fig. 3: Algorithm model for decision support model of the basil plant

Complementing the class diagram which was described in Fig. 1 in explaining how the upcoming model will going to be developed, the process of the decision-making system in determining strategic decisions will be explained in this algorithm model. The algorithm model is made to show how the process of DSM using this fuzzy method can produce decisions based on the model that has been made. For an overview of the algorithm, this model is made using activity diagrams so that each process can be more clearly displayed on the system and could provide a better understanding of the overall process. The activity diagram of this algorithm model can be seen in Fig. 3.

It can be seen in Fig. 3 initially the modeling process to produce this strategic decision began with the planting period of this Basil plant (*Ocimum basillicum P.*) until it reached its harvest season. Then, the average weight of this basil plant will be collected including the price of components that supports it as mentioned in Table 2 to 4. From this data, it will be processed into language-based variables (linguistic variables), then mapped into membership functions based on the degree of value of truth (Degree of Truth, DoT). The form of the language variable used to create the membership function in this study uses a triangular and trapezoidal membership function which can be seen in Fig. 4.

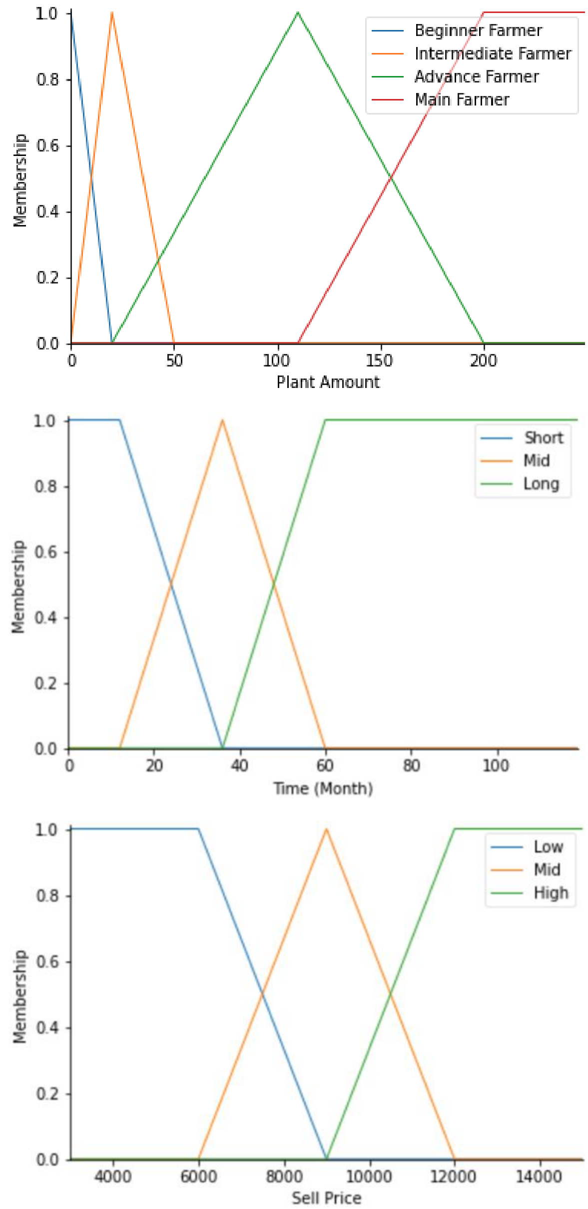

Fig. 4: Membership function of the number of plants (upper), sell price (middle), and time in a monthly interval (bottom)

The equation that will determine the ROI, NPV, and BC Ratio value will also involve the time parameter. Considering that those value might be varied depends on when it was being measured. To make the results more relevant, this study will be depicting ROI, NPV, and BC ratios every month for up to 10 years. In this step, we gather those ranged input membership function parameters so we could calculate those inputted parameters into several investment analysis mathematical equations afterward. After finding the results membership function from the types of data that have been taken, then the fuzzification process can be carried out. This fuzzification process produces a knowledge base which will be processed at the inference system stage. After the inference system, a series of IF_THEN conditions are obtained which are commonly referred to as rule base, to be used later by a decision support system based on the language-based variables. The rule base for each investment analysis will be carried out as follows.

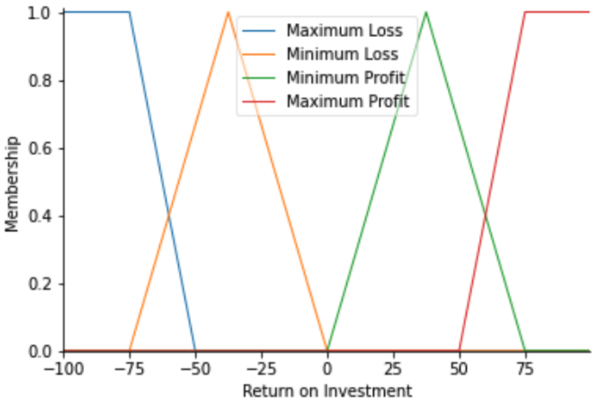

Fig. 5: ROI membership function

Return on Investment (RoI)

The ROI equation result will be classified into 4 categories respectively "Maximum Loss", "Minimum Loss", "Minimum Profit", and "Maximum Profit". Each classification value was initiated based on experimental results by applying ranged values to related input parameters. The value of each category will be represented as a membership function as shown in Fig. 5, and the defined inference system rule-base according to our empirical study will be shown in Table 5.

Table 5: ROI Rule-based inference system

Rule 1	—
Rule 2	IF (sell_price['Low'] AND amount['Beginner Farmer'] AND time['Short']) OR (sell_price['Low'] AND amount['Intermediate Farmer'] AND time['Short']) OR (sell_price['Low'] AND amount['Advance Farmer'] AND time['Short']) OR (sell_price['Low'] AND amount['Main Farmer'] AND time['Short']) THEN ROI['Minimum Loss']
Rule 3	IF (sell_price['Low'] AND amount['Beginner Farmer'] AND time['Mid']) OR (sell_price['Low'] AND amount['Beginner Farmer'] AND time['Long']) OR (sell_price['Low'] AND amount['Intermediate Farmer'] AND time['Mid']) OR (sell_price['Low'] AND amount['Intermediate Farmer'] AND time['Long']) OR (sell_price['Low'] AND amount['Advance Farmer'] AND time['Mid']) OR (sell_price['Low'] AND amount['Advance Farmer'] AND time['Long']) OR (sell_price['Low'] AND amount['Main Farmer'] AND time['Mid']) OR (sell_price['Low'] AND amount['Main Farmer'] AND time['Long']) OR (sell_price['Mid'] AND amount['Beginner Farmer'] AND time['Short']) OR (sell_price['Mid'] AND amount['Beginner Farmer'] AND time['Mid']) OR (sell_price['Mid'] AND amount['Beginner Farmer'] AND time['Long']) OR (sell_price['Mid'] AND amount['Intermediate Farmer'] AND time['Short']) OR (sell_price['Mid'] AND amount['Intermediate Farmer'] AND time['Mid']) OR (sell_price['Mid'] AND amount['Intermediate Farmer'] AND time['Long']) OR (sell_price['Mid'] AND amount['Advance Farmer'] AND time['Short']) OR (sell_price['Mid'] AND amount['Advance Farmer'] AND time['Mid']) OR (sell_price['Mid'] AND amount['Advance Farmer'] AND time['Long']) OR (sell_price['Mid'] AND amount['Main Farmer'] AND time['Short']) OR (sell_price['Mid'] AND amount['Main Farmer'] AND time['Mid']) OR (sell_price['Mid'] AND amount['Main Farmer'] AND time['Long']) OR (sell_price['High'] AND amount['Beginner Farmer'] AND time['Short']) OR (sell_price['High'] AND amount['Beginner Farmer'] AND time['Mid']) OR (sell_price['High'] AND amount['Intermediate Farmer'] AND time['Short']) OR (sell_price['High'] AND amount['Intermediate Farmer'] AND time['Mid']) OR (sell_price['High'] AND amount['Advance Farmer'] AND time['Short']) OR (sell_price['High'] AND amount['Advance Farmer'] AND time['Mid']) OR (sell_price['High'] AND amount['Main Farmer'] AND time['Short']) OR (sell_price['High'] AND amount['Main Farmer'] AND time['Mid']) THEN ROI['Minimum Profit']
Rule 4	IF (sell_price['High'] AND amount['Beginner Farmer'] AND time['Mid']) OR (sell_price['High'] AND amount['Beginner Farmer'] AND time['Long']) OR (sell_price['High'] AND amount['Intermediate Farmer'] AND time['Mid']) OR (sell_price['High'] AND amount['Intermediate Farmer'] AND time['Long']) OR (sell_price['High'] AND amount['Advance Farmer'] AND time['Mid']) OR (sell_price['High'] AND amount['Advance Farmer'] AND time['Long']) OR (sell_price['High'] AND amount['Main Farmer'] AND time['Mid']) OR (sell_price['High'] AND amount['Main Farmer'] AND time['Long']) THEN ROI['Maximum Profit']

Net Present Value (NPV)

Unlike the ROI, the NPV value was heavily dependent on the number of plants and sell price parameters, so there will be a big difference between the calculation and the result may be too subjective to be measured. As the objective of this study was to achieve a result on whether this plantation was a worthy investment. So, the classification of NPV will only involve 2 categories respectively, which are negative and positive. Negative variables represent the differences between the amount of present value of cash inflows that cannot cover the present value of cash outflow over some time (cycle). Thus, financial reports in that period will only be generating losses instead of profits and resulting in a negative value. On the contrary, the positive variable represents a positive value over the differences between the present value of cash inflows and the present value of cash outflow at that period, thus rewarded in profits. The rule-base results established after an experimental result on the related parameter will be shown in Table 6.

Table 6. NPV rule-based inference system

Rule 1	—
Rule 2	IF (sell_price['Low'] & amount['Beginner Farmer'] & time['Short']) | (sell_price['Low'] & amount['Beginner Farmer'] & time['Mid']) | (sell_price['Low'] & amount['Beginner Farmer'] & time['Long']) | (sell_price['Low'] & amount['Intermediate Farmer'] & time['Short']) | (sell_price['Low'] & amount['Intermediate Farmer'] & time['Mid']) | (sell_price['Low'] & amount['Intermediate Farmer'] & time['Long']) | (sell_price['Low'] & amount['Advance Farmer'] & time['Short']) | (sell_price['Low'] & amount['Advance Farmer'] & time['Mid']) | (sell_price['Low'] & amount['Advance Farmer'] & time['Long']) | (sell_price['Low'] & amount['Main Farmer'] & time['Short']) | (sell_price['Low'] & amount['Main Farmer'] & time['Mid']) | (sell_price['Low'] & amount['Main Farmer'] & time['Long']) | (sell_price['Mid'] & amount['Beginner Farmer'] & time['Short']) | (sell_price['Mid'] & amount['Beginner Farmer'] & time['Mid']) | (sell_price['Mid'] & amount['Beginner Farmer'] & time['Long']) | (sell_price['Mid'] & amount['Intermediate Farmer'] & time['Short']) | (sell_price['Mid'] & amount['Intermediate Farmer'] & time['Mid']) | (sell_price['Mid'] & amount['Intermediate Farmer'] & time['Long']) | (sell_price['Mid'] & amount['Advance Farmer'] & time['Short']) | (sell_price['Mid'] & amount['Advance Farmer'] & time['Mid']) | (sell_price['Mid'] & amount['Advance Farmer'] & time['Long']) | (sell_price['Mid'] & amount['Main Farmer'] & time['Short']) | (sell_price['Mid'] & amount['Main Farmer'] & time['Mid']) | (sell_price['Mid'] & amount['Main Farmer'] & time['Long']) | (sell_price['High'] & amount['Beginner Farmer'] & time['Short']) | (sell_price['High'] & amount['Beginner Farmer'] & time['Mid']) | (sell_price['High'] & amount['Beginner Farmer'] & time['Long']) | (sell_price['High'] & amount['Intermediate Farmer'] & time['Short']) | (sell_price['High'] & amount['Intermediate Farmer'] & time['Mid']) | (sell_price['High'] & amount['Intermediate Farmer'] & time['Long']) | (sell_price['High'] & amount['Advance Farmer'] & time['Short']) | (sell_price['High'] & amount['Advance Farmer'] & time['Mid']) | (sell_price['High'] & amount['Advance Farmer'] & time['Long']) | (sell_price['High'] & amount['Main Farmer'] & time['Short']) | (sell_price['High'] & amount['Main Farmer'] & time['Mid']) | (sell_price['High'] & amount['Main Farmer'] & time['Long']) | THEN NPV['Positive'])

BC Ratio

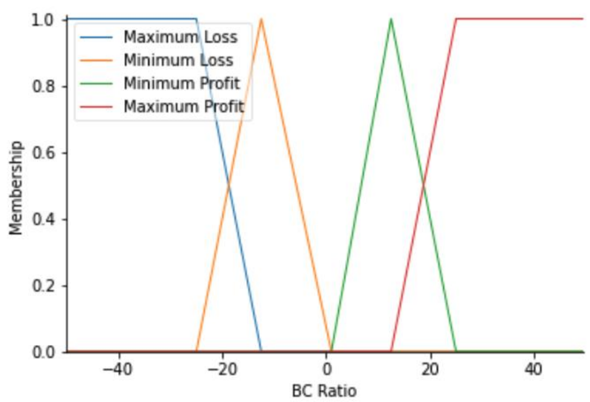

Fig. 6: BCR membership function

BC Ratio will also be classified into 4 categories respectively "Maximum Loss", "Minimum Loss", "Minimum Profit", and "Maximum Profit". With value 1 as an indicator of whether the investment is expected to deliver profits or losses. The value of each category will be represented as a membership function as shown in Fig. 6 and the following rule-based results will be shown in Table 7.

Table 7: BC ratio rule-based inference system

Rule 1	—
Rule 2	IF (sell_price['Low'] AND amount['Beginner Farmer'] AND time['Short']) OR (sell_price['Low'] AND amount['Intermediate Farmer'] AND time['Short']) OR (sell_price['Low'] AND amount['Advance Farmer'] AND time['Short']) OR (sell_price['Low'] AND amount['Main Farmer'] AND time['Short']) THEN BCR['Minimum Loss'])
Rule 3	IF (sell_price['Low'] AND amount['Beginner Farmer'] AND time['Mid']) OR (sell_price['Low'] AND amount['Beginner Farmer'] AND time['Long']) OR (sell_price['Low'] AND amount['Intermediate Farmer'] AND time['Mid']) OR (sell_price['Low'] AND amount['Intermediate Farmer'] AND time['Long']) OR (sell_price['Low'] AND amount['Advance Farmer'] AND time['Mid']) OR (sell_price['Low'] AND amount['Advance Farmer'] AND time['Long']) OR (sell_price['Low'] AND amount['Main Farmer'] AND time['Mid']) OR (sell_price['Low'] AND amount['Main Farmer'] AND time['Long']) OR (sell_price['Mid'] AND amount['Beginner Farmer'] AND time['Short']) OR (sell_price['Mid'] AND amount['Beginner Farmer'] AND time['Mid']) OR (sell_price['Mid'] AND amount['Beginner Farmer'] AND time['Long']) OR (sell_price['Mid'] AND amount['Intermediate Farmer'] AND time['Short']) OR (sell_price['Mid'] AND amount['Intermediate Farmer'] AND time['Mid']) OR (sell_price['Mid'] AND amount['Intermediate Farmer'] AND time['Long']) OR (sell_price['Mid'] AND amount['Advance Farmer'] AND time['Short']) OR (sell_price['Mid'] AND amount['Advance Farmer'] AND time['Mid']) OR (sell_price['Mid'] AND amount['Advance Farmer'] AND time['Long']) OR (sell_price['Mid'] AND amount['Main Farmer'] AND time['Short']) OR (sell_price['Mid'] AND amount['Main Farmer'] AND time['Mid']) OR (sell_price['Mid'] AND amount['Main Farmer'] AND time['Long']) OR (sell_price['High'] AND amount['Beginner Farmer'] AND time['Short']) OR (sell_price['High'] AND amount['Intermediate Farmer'] AND time['Short']) OR (sell_price['High'] AND amount['Advance Farmer'] AND time['Short']) OR (sell_price['High'] AND amount['Main Farmer'] AND time['Short']) THEN BCR['Minimum Profit'])
Rule 4	IF (sell_price['High'] AND amount['Beginner Farmer'] AND time['Short']) OR (sell_price['High'] AND amount['Beginner Farmer'] AND time['Mid']) OR (sell_price['High'] AND amount['Beginner Farmer'] AND time['Long']) OR (sell_price['High'] AND amount['Intermediate Farmer'] AND time['Short']) OR (sell_price['High'] AND amount['Intermediate Farmer'] AND time['Mid']) OR (sell_price['High'] AND amount['Intermediate Farmer'] AND time['Long']) OR (sell_price['High'] AND amount['Advance Farmer'] AND time['Short']) OR (sell_price['High'] AND amount['Advance Farmer'] AND time['Mid']) OR (sell_price['High'] AND amount['Advance Farmer'] AND time['Long']) OR (sell_price['High'] AND amount['Main Farmer'] AND time['Short']) OR (sell_price['High'] AND amount['Main Farmer'] AND time['Mid']) OR (sell_price['High'] AND amount['Main Farmer'] AND time['Long']) THEN BCR['Maximum Profit'])

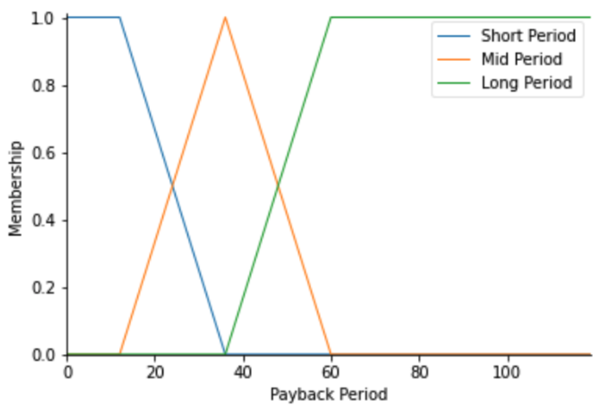

Fig. 7: Payback period membership function

Payback Period

Unlike any other equation that requires time as its initial input for generating the result of the related model. The main purpose of the PP equation was to find a period when the investment return had finally recovered from its initial investment cost. The classification of this equation will be classified respectively as "Short", "Mid", and "Long". The financial situation on the stakeholder end might cause each classification value to be subjective to initiate. We then rely on experimental data we applied to the equation to find its shortest and longest period. The representation will be depicted monthly as each harvesting cycle requires around 2 months. The value of each category will be represented as a membership function as shown in Fig. 7 and each set of rules will be described in Table 8. Based on the associated membership function.

Table 8: Payback period rule-based inference system

Rule 1	IF (sell_price['Low'] AND amount['Beginner Farmer'] AND time['Short']) OR
	(sell_price['Low'] AND amount['Beginner Farmer'] AND time['Mid']) OR
	(sell_price['Low'] AND amount['Beginner Farmer'] AND time['Long']) OR
	(sell_price['Low'] AND amount['Intermediate Farmer'] AND time['Short']) OR
	(sell_price['Low'] AND amount['Intermediate Farmer'] AND time['Mid']) OR
	(sell_price['Low'] AND amount['Intermediate Farmer'] AND time['Long']) OR
	(sell_price['Low'] AND amount['Advance Farmer'] AND time['Short']) OR
	(sell_price['Low'] AND amount['Advance Farmer'] AND time['Mid']) OR
	(sell_price['Low'] AND amount['Advance Farmer'] AND time['Long']) OR
	(sell_price['Low'] AND amount['Main Farmer'] AND time['Short']) OR
	(sell_price['Low'] AND amount['Main Farmer'] AND time['Mid']) OR
	(sell_price['Low'] AND amount['Main Farmer'] AND time['Long']) OR
	(sell_price['Mid'] AND amount['Beginner Farmer'] AND time['Short']) OR
	(sell_price['Mid'] AND amount['Beginner Farmer'] AND time['Mid']) OR
	(sell_price['Mid'] AND amount['Beginner Farmer'] AND time['Long']) OR
	(sell_price['Mid'] AND amount['Intermediate Farmer'] AND time['Short']) OR
	(sell_price['Mid'] AND amount['Intermediate Farmer'] AND time['Mid']) OR
	(sell_price['Mid'] AND amount['Intermediate Farmer'] AND time['Long']) OR
	(sell_price['Mid'] AND amount['Advance Farmer'] AND time['Short']) OR
	(sell_price['Mid'] AND amount['Advance Farmer'] AND time['Mid']) OR
	(sell_price['Mid'] AND amount['Advance Farmer'] AND time['Long']) OR
	(sell_price['Mid'] AND amount['Main Farmer'] AND time['Short']) OR
	(sell_price['Mid'] AND amount['Main Farmer'] AND time['Mid']) OR
	(sell_price['Mid'] AND amount['Main Farmer'] AND time['Long']) OR
	(sell_price['High'] AND amount['Beginner Farmer'] AND time['Short']) OR
	(sell_price['High'] AND amount['Beginner Farmer'] AND time['Mid']) OR
	(sell_price['High'] AND amount['Beginner Farmer'] AND time['Long']) OR
	(sell_price['High'] AND amount['Intermediate Farmer'] AND time['Short']) OR
	(sell_price['High'] AND amount['Intermediate Farmer'] AND time['Mid']) OR
	(sell_price['High'] AND amount['Intermediate Farmer'] AND time['Long']) OR
	(sell_price['High'] AND amount['Advance Farmer'] AND time['Short']) OR
	(sell_price['High'] AND amount['Advance Farmer'] AND time['Mid']) OR
	(sell_price['High'] AND amount['Advance Farmer'] AND time['Long']) OR
	(sell_price['High'] AND amount['Main Farmer'] AND time['Short']) OR
	(sell_price['High'] AND amount['Main Farmer'] AND time['Mid']) OR
	(sell_price['High'] AND amount['Main Farmer'] AND time['Long'])
	THEN PP['Short Period'])
Rule 2	—
Rule 3	—

From the value, the crisp output is a representation of the decisions that will be taken based on the average value of these rules and the value knowledge-based in the fuzzification process, so that the value can then be applied to real planting based on the final process of algorithm model (Utama, 2017):

$$Y = Y_1 + \frac{Y_2 - Y_1}{X_2 - X_1}\left(X - X_1\right) \tag{5}$$

The DoT value then passes through its final destination in measuring the crisp output value by passing the defuzzification process. Weighted mean and centroid formula will be used in this process where the centroid value on each membership function was represented by Z whereas $\mu(Z`)$ and $\mu(Z)$ is representing the membership value. Both equations were shown in Eq. 6 and 7 (Hartanto and Utama, 2020):

$$Weighted\ Mean = \frac{\sum \mu(Z')\cdot Z'}{\sum \mu(Z')} \tag{6}$$

$$Centroid = \frac{\int \mu(Z)\cdot Z\,dZ}{\int \mu(Z)dZ} \tag{7}$$

From the value, the crisp output is a representation of the decisions that will be taken based on the average value of these rules and the value knowledge based on the fuzzification process, so that the value can then be applied to the real plantation based on the last process of the algorithm model (Utama, 2017).

The outcomes of this fuzzy logic, which were achieved by the prior fuzzification, inference system, and defuzzification stages, are fully stated in Table 9. The first three columns, which include the sale price, quantity, and time, describe three elements relevant to the precise input of the membership function, which depicts every conceivable real-event situation. The final four columns, ROI, NPV, BC ratio, and PP, describe the output of the computed fuzzy logic that generates a value based on each unit of measurement (i.e., ROI equals -12,5 means the ROI was -12.5%, thus resulting in an investment loss). And these figures will indicate whether each scenario resulted in a loss or a profitable investment.

Table 9: DSM result value suggestion for ROI, BEP, and BC ratio

Sell Price (IDR)	Quantity	Time (month)	ROI (%)	NPV	BC ratio	PP (1 period = 2 month)
4.200	9	6	-12,5	5.136.153,93	-1,5	14,947
4.200	9	24	0	5.123.881,61	1	15,2
4.200	9	60	12,5	5.136.153,93	3,5	14,947
4.200	36	6	-12,5	5.115.687,57	-1,5	15,372
4.200	36	24	0	5.115.687,57	1	15,372
4.200	36	60	12,5	5.115.687,57	3,5	15,372
4.200	78	6	-12,5	5.159.273,02	-1,5	14,486
4.200	78	24	0	5.123.881,61	1	15,2
4.200	78	60	12,5	5.159.273,02	3,5	14,486
4.200	200	6	-12,5	5.245.563,99	-1,5	13
4.200	200	24	0	5.123.881,61	1	15,2
4.200	200	60	12,5	5.245.563,99	3,5	13
7.000	9	6	-2,235	5.136.153,93	0,553	14,947
7.000	9	24	0	5.123.881,61	1	15,2
7.000	9	60	12,5	5.136.153,93	3,5	14,947
7.000	36	6	-1,573	5.115.687,57	0,685	15,372
7.000	36	24	0	5.115.687,57	1	15,372
7.000	36	60	12,5	5.115.687,57	3,5	15,372
7.000	78	6	-2,782	5.159.273,02	0,444	14,486
7.000	78	24	0	5.123.881,61	1	15,2
7.000	78	60	12,5	5.159.273,02	3,5	14,486
7.000	200	6	-2,885	5.164.700,94	0,423	14,381
7.000	200	24	0	5.123.881,61	1	15,2
7.000	200	60	12,5	5.164.700,94	3,5	14,381
16.000	9	6	12,5	5.136.153,93	8,588	14,947
16.000	9	24	26,277	5.123.881,61	8,558	15,2
16.000	9	60	32,66	5.136.153,93	9,837	14,947
16.000	36	6	12,5	5.115.687,57	8,538	15,372
16.000	36	24	26,178	5.115.687,57	8,538	15,372
16.000	36	60	32,417	5.115.687,57	9,787	15,372
16.000	78	6	12,5	5.159.273,02	8,657	14,486
16.000	78	24	26,277	5.123.881,61	8,558	15,2
16.000	78	60	32,932	5.159.273,02	9,893	14,486
16.000	200	6	12,5	5.245.563,99	9,05	13
16.000	200	24	26,277	5.123.881,61	8,558	15,2
16.000	200	60	33,913	5.245.563,99	10,101	13

Conclusion

This study is trying to generate the Decision Support Model for assessing the potential investment in Basil Plant (*Ocimum basillicum*). The investment analysis equation that is being used in this study is based on the financial aspect of the feasibility study. Which was commonly used in planning and forecasting financial gains of a project or investment. An equation such as Return on Investment (RoI), Net Present Value (NPV), Benefit/Cost Ratio (BCR), and Payback Period (PP) is being used in this study to assess those potential investments. Plant weight, initial capital, time, number of plants, and operating cost are among the inputs utilized in this study to obtain membership function value. Some of the values may remain constant due to page limitations in covering every possibility. According to the DSM model, the investment needs to happen over a long period to gain its maximum potential return. The PP will not be affected by the number of plants being planted but is hardly dependent on the selling price of each plant. As we all know, to maximize our profits, we must increase the selling price on each transaction as much as feasible. But, considering that this study does not cover the product acceptance of each crop from its customers, selling prices need to be set at a competitive price to keep up with the demand.

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titled "A literature review: Feasibility Study of technology to improve shopping experience".

Author's Contributions

Heraldo Yusron Purwantono: Carried out the investment metrics calculation, cultivation processes, and other technical detail in constructing the decision model.

Ditdit Nugeraha Utama: Involve in initiating the method of Decision Support Model (DSM) with Fuzzy Logic implementation for assessing crop yield for this research along framework that supports, since this implementation was a continuity of his dissertation. Choosing Basil Plant (*Ocimum Basillicum P*.) as research object and supervising the planting and writing process of this research. We both decide which investment and parameters that are suitable for the decision model and we both write and reviewed the manuscript as well.

Ethics

This manuscript substance is the author's original work and has not been previously published somewhere else. Authors already read and approved the manuscript and no potential ethical issues are immersed.

References

Abou, A., Ebrahim, S., & Awad, A. (2011). A fuzzy decision support system for management of breast cancer. *International Journal of Advanced Computer Science and Applications*, 2(3), 34–40. doi.org/10.14569/ijacsa.2011.020307

Boloş, M. I., Bradea, I. A., & Delcea, C. (2019). A fuzzy logic algorithm for optimizing the investment decisions within companies. *Symmetry*, 11(2). doi.org/10.3390/sym11020186

Cahyani, N. M. E. (2014). Daun Kemangi (Ocinum Cannum) Sebagai Alternatif Pembuatan Handsanitizier. KEMAS: *Jurnal Kesehatan Masyarakat*, 9(2), 136–142. doi.org/10.15294/kemas.v9i2.2843

Casanova, I. J. (2012). The Portfolio investment decision support system is based on a fuzzy inference system. *Studies in Computational Intelligence*, 399(March), 183–196. doi.org/10.1007/978-3-642-27534-0_12

Elysia, C., & Utama, D. N. (2020). Decision support model for optimal decision in strategic production planning based on the product life cycle. *ICIC Express Letters, Part B: Applications*, 11(12), 1105–1114. doi.org/10.24507/icicelb.11.12.1105

Gandhi, N., Armstrong, L. J., & Petkar, O. (2016, July). Proposed decision support system (DSS) for Indian rice crop yield prediction. In 2016 *IEEE Technological Innovations in ICT for Agriculture and Rural Development (TIAR)* (pp. 13-18). IEEE. doi.org/10.1109/TIAR.2016.7801205

Gischa, S. (2021). Jumlah Penduduk Indonesia. *Kompas*. https://www.kompas.com/skola/read/2020/01/08/060000069/jumlah-penduduk-indonesia-2020?page=all

Gunawan, F., Wang, G., Utama, D. N., Komsiyah, S., & Suharjito. (2018). Decision support model for supplier selection using the fuzzy logic concept. *Proceedings of* 2018 *International Conference on Information Management and Technology*, (*ICIMTech)* 2018, September, 394–399. doi.org/10.1109/ICIMTech.2018.8528103

Ritchie, H., Mathieu, E., Rodés-Guirao, L., Appel, C., Giattino, C., Ortiz-Ospina, E., Hasell, J., Macdonald, B., Beltekian, D., & Roser, M. (2020). Coronavirus Pandemic (COVID-19). *Our World in Data. Org*. https://ourworldindata.org/covid-deaths#citation

Hartanto, M., & Utama, D. N. (2020). Intelligent decision support model for recommending a restaurant. *Cogent Engineering*, 7(1), 1763888. doi.org/10.1080/23311916.2020.1763888

Jakfar, & Kashmir. (2012). Studi Kelayakan Bisnis. *Kencana Prenada Media*.

Jankova, Z., Jana, D. K., & Dostal, P. (2021). Investment decision support based on interval type-2 fuzzy expert system. *Engineering Economics*, 32(2), 118–129. doi.org/10.5755/j01.ee.32.2.24884

Kumar, D., Singh, J., Singh, O. P., & Seema. (2013). Fuzzy logic-based decision support system for evaluation of suppliers in supply chain management practices. *Mathematical and Computer Modelling*, 57(11–12), 2945–2960. doi.org/10.1016/j.mcm.2013.03.002

Pertanian, S. J. K. (2019). Statitik Lahan Pertanian Tahun 2014-2018. https://www.bps.go.id/indicator/53/179/1/luas-lahan-sawah.html

Peter, K. v. (2012). Handbook of herbs and spices. *In the handbook of herbs and spices.* doi.org/10.1533/9780857095688

Setya, D. (2020). Sayuran dan Ayam Tak Laku, Petani Bagikan Gratis pada Warga. *Detik. Com*. https://food.detik.com/info-kuliner/d-5159784/sayuran-dan-ayam-tak-laku-petani-bagikan-gratis-pada-warga/1

Shamshiri, R. R., Kalantari, F., Ting, K. C., Thorp, K. R., Hameed, I. A., Weltzien, C., Ahmad, D., & Shad, Z. (2018). Advances in greenhouse automation and controlled environment agriculture: A transition to plant factories and urban agriculture. *International Journal of Agricultural and Biological Engineering*, 11(1), 1–22. doi.org/10.25165/j.ijabe.20181101.3210

Shirzad, S., Barjesteh, H., Dehqan, M., & Zare, M. (2021). The Interplay among EFL Students' Epistemic Beliefs, Language Learning Strategies, and L2 Motivational Self System: A Structural Equation Modeling Approach. *Journal of Modern Research in English Language Studies*, 8(1), 169–195. doi.org/10.30479/jmrels.2020.12621.1562

Utama, D. N. (2017). Sistem Penunjang Keputusan: Filosofi Teori dan Implementasi. *In Garudhawaca* (Issue April). *Garudhawaca*.

Utama, D. N., Rustamaji, E., & Fauziyah, A. (2018). Fuzzy eco-DSM for treating medical waste. *IOP Conference Series: Earth and Environmental Science*, 195(1). doi.org/10.1088/1755-1315/195/1/012050

Viviano, F. (2017). This tiny country feeds the World. *National Geographic*. https://www.nationalgeographic.com/magazine/article/holland-agriculture-sustainable-farming

Wadgaonkar, J., & Bhole, K. (2017). Fuzzy logic-based decision support system. *India International Conference on Information Processing, IICIP* 2016-*Proceedings*,1-4. doi.org/10.1109/IICIP.2016.7975310