Evaluation of Chicken Eggs Supply With Fuzzy AHP Approach Through Development of Safea Software

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ABSTRACT

This study aims to evaluate the supply aspect of chicken eggs. The Variables used in this research were egg stock, egg demand, and selling prices with alternatives are adding suppliers, adding customers, reducing supplier. The method of this research using Fuzzy AHp where The membership sets of fuzzy model are Triangular and Trapezodial membership function. The results of the research indicate that the main priority as a decision support for the supply of chicken egss is the selling price to customer (0,67), so that the alternative priority option is the addition of suppliers (0,75) to anticipate imbalances between the number of eggs sold and stock availability in the warehouse.

1. INTRODUCTION

Chicken eggs are a food product that is consumed by the people of Indonesia as a supporter of nutritional intake because it is the best source of protein at a low price. In addition, chicken eggs can also be used as additional ingredients for processed products. Chicken egg supply chain activities from egg farmers (Supplier) to consumers use egg agents as the first channel. Egg agents must get a supply of products in quantity and quality that is in accordance with market demand.

The complexity of managing the supply of egg agents is increasing along with the increase in the number of egg sales reaching 350 crates. The problems that arise today are very complex because egg agents are faced with problems, namely egg agents cannot determine the optimal number of orders so that supply is maintained and stock does not accumulate in the warehouse. Therefore, continuous evaluation is needed by the Egg Agent in order to get the right supply. The business process management approach strategy refers to a pull strategy where the movement of goods is focused on 1) order management on the supply side and 2) customer service on the demand side to minimize waste and inventory [1].

2. LITERATURE REVIEW

Supply management by taking into account the economic value includes supply selection, evaluation of supply, and supply management [2]. Performance measurement of suppliers plays a very significant role in the ordering process. The fuzzy AHP method is used for the best supplier selection where the incorporation of explicit steps used in the supplier selection process in the industry when there are many confusing performance measures can make decision makers take a policy.

[3] shows the use of the Fuzzy AHP method in measuring supplier performance using several criteria, namely quality, delivery, completeness, and environmental management. It shows that the best supplier performance can be determined. The results showed that the quality of packaging has the best criteria for the best alternative supplier selection in the food industry. The results of other studies show the development of a framework of perspective criteria covering finance, customers, internal business, and company growth to be

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able to achieve the objectives of measuring supplier performance [4]. Environmental criteria in supplier selection practices are important in the agri-food industry. The results show that environmental criteria for supplier selection models can help overcome many of the challenges facing procurement and inventory [5].

3. RESEARCH METHODOLOGY

This study uses the Fuzzy AHP model as a decision support tool for egg supply at the Egg Agent with the development of a SAFEA smart application tool. The Fuzzy AHP model uses criteria for improvement, namely selling price, egg demand and stock are used to evaluate the performance of chicken egg suppliers. Integration is carried out between the fuzzy model and the AHP structure.

The fuzzy logic approach can be developed into a flexible programming model because the fuzzy membership set was developed objectively to be able to assess with certainty the fuzzy input and output variables, making it easier to make decisions [6]. AHP is used to make decisions in an organized manner to generate priorities, where the stages in making AHP are as follows: [7] :

1. **Define the problem**. Defining the problem and determining the type of knowledge sought.
2. **Preparation of the decision hierarchy structure**. The hierarchy starts from the top level with a decision goal, from a broad perspective through the middle level a set of criteria where the next element depends on the lowest level called a series of alternatives.
3. **Determination of pairwise comparison matrix**. Each element at the top level is used to compare the elements at the bottom level.
4. **Priority determination**. Priorities obtained from comparisons to weigh priorities at lower levels. This determination is made for each element. Next, each element adds its weight values and gets the overall priority. This process continues until the final priority of the lowest-level alternatives is obtained.

Integration of AHP with Fuzzy model in determining the weight of the comparison assessment matrix [8]. The stages in the Fuzzy AHP model are as follows:

1. Step-1: Build AHP structures by experts
   In this step, the determination of decision-making objectives, relative criteria. In addition, the ranking of the comparison matrix modeled by fuzzy numbers can be given by experts through linguistic variables.
2. Step-2: For each criterion, use the canonical representation of the multiplication operation on fuzzy numbers to obtain a comparison matrix with the canonical representation of the multiplication operation. The relationship between uncertain variables and expert opinion is used as a reference for developing fuzzy logic models [9]. Fuzzy membership function model in generating fuzzy numbers can be applied to other operational aspects including the optimal number of orders [10], production capacity [11], production machine performance[12].
3. Step-3: Determination of the average weight of the criteria.

$$w_{Ci}^{av} = \frac{1}{N}\sum_{1}^{N} w_{Ci}^{CR} \quad (1)$$

4. Step-4: Determination of the final weight of each criterion by normalizing each average weight of the criteria.

$$w_{Ci}^{f} = \frac{w_{Ci}^{av}}{\sum_{I}^{N} w_{Ci}^{av}} \quad (2)$$

4. RESULTS AND DISCUSSION

4.1. Define the Problem

The results of chicken egg production from farmers will be sent to large agents where these large agents will distribute them to small agents so that they can be reached by consumers, both business consumers and final consumers. Consumers can directly come to the egg agent to buy chicken eggs in the form of crates, kg, broken eggs. Egg agents are actors in supply chain activities that play an important role in the process of distributing products to consumers, so they require management of supply and demand for chicken eggs.

This management aims to keep the stock of eggs not too long in the warehouse, causing the eggs to rot and cannot be sold. Management of supply activities in the chicken egg agent business process is very necessary because the egg agent's storage capacity currently reaches a maximum level of 350 crates. The limitations of

analytical tools related to the selection of supply improvement alternatives often lead to buildup in the warehouse.

4.2. Decision Hierarchy Structure

The Analytical Hierarchy Process (AHP) model uses a structure starting from the goals to be achieved, the selection of criteria, and alternative choices. The goal to be achieved is to evaluate the existing supply of the Egg Agent so that there can be improvements on the supply side of chicken eggs. In addition, the criteria set in this study are the selling price of chicken eggs, the demand for chicken eggs, and the stock of eggs in the warehouse. These criteria depend on the selection of alternatives to achieve the desired goals. The alternative choices are by reducing suppliers, adding suppliers, and also by adding consumers. The decision hierarchy can be presented in the figure 1.

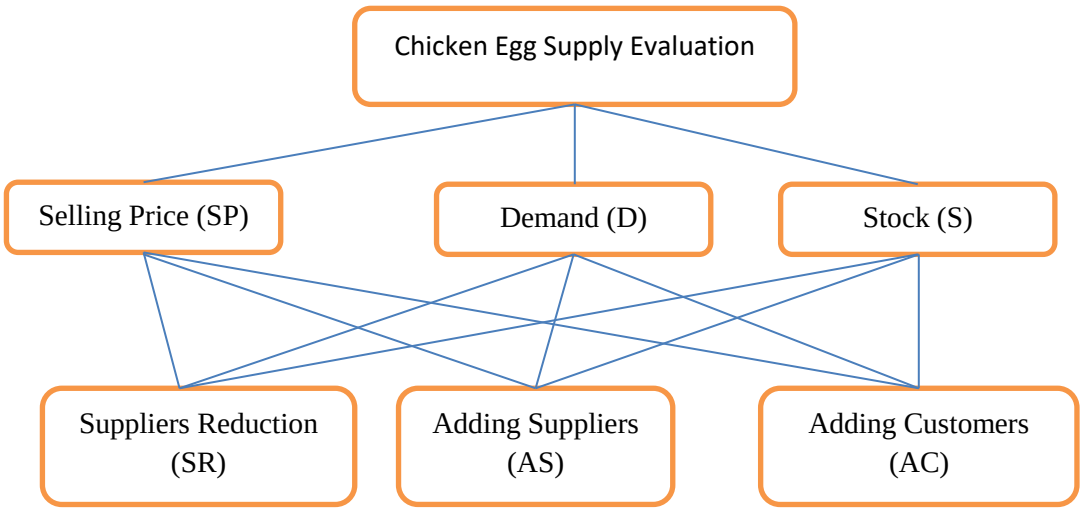

Figure 1. Decision Hierarchy Structure

4.3. Pairwise Comparison

The determination of the value of pairwise comparison was obtained from the results of interviews with egg agents related to the condition of egg supply. Based on the results of the fuzzy membership set of pairwise comparison values for the criteria for selling price (SP), demand (D), and the number of egg stock (S) as well as the alternatives formed, namely Suppliers Reduction (SR), Adding Suppliers (AS), and Adding Consumers (AC) can be presented in Table 1. The comparison value of the criteria above will then be converted into numbers based on the membership set above. The value of the fuzzy comparison criteria can be presented in Table 2.

Table 1. Criteria Comparison

Goal	SP	D	S

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SP	1	5	4
D	0,20	1	3
S	0,25	0,33	1

Table 2. Fuzzy value comparison criteria

Goal	SP			D			S			Value (Wi)			Fuzzy Weight (Wi)			Center of Area (Wi)	Normalised Weight
										1	2	3	1	2	3		
SP	1	1	1	4	5	6	3	4	5	2,27	2,69	3,07	0,49	0,68	0,92	0,70	0,67
D	0,17	0,20	0,25	1	1	1	2	3	4	0,70	0,84	1,00	0,15	0,21	0,30	0,22	0,21
S	0,20	0,25	0,33	0,25	0,33	0,50	1	1	1	0,37	0,44	0,55	0,08	0,11	0,17	0,12	0,11
			TOTAL							3,34	3,97	4,63				1,04	1,00

Based on the results of the comparison of these criteria, the main priority for the goal to be achieved is the evaluation of the supply of egg products by taking into account the alternatives that have been determined. Fuzzy value comparison of alternatives can be presented from Table 3 to Table 8.

Table 3. The value of the comparison of the Selling Price alternatives (SP)

SP	SR	AS	AC
SR	1	7	6
AS	0,14	1	2
AC	0,17	0,5	1

Table 4. Fuzzy Value Comparison of Selling Price alternatives (SP)

SP	SR			AS			AC			Value (Wi)			Fuzzy Weight (Wi)			Center of Area (Wi)	Normalised Weight
										1	2	3	1	2	3		
SR	1	1	1	6	7	8	5	6	7	3,07	3,43	3,77	0,60	0,76	0,96	0,77	0,75
AS	0,13	0,14	0,17	1	1	1	1	2	3	0,50	0,66	0,80	0,10	0,15	0,20	0,15	0,14
AC	0,14	0,17	0,20	0,33	0,50	1,00	1	1	1	0,37	0,44	0,59	0,07	0,10	0,15	0,11	0,10
			TOTAL							3,94	4,53	5,16				1,02	1,00

Table 5. The value of the comparison of the Demand alternatives (D)

D	SR	AS	AC
SR	1	4	3

AS	0,25	1	8
AC	0,33	0,125	1

Table 6. Fuzzy Value Comparison of Demand alternatives (D)

D	SR			AS			AC			Value (Wi)			Fuzzy Weight (Wi)			Center of Area (Wi)	Normalised Weight
										1	2	3	1	2	3		
SR	1	1	1	3	4	5	2	3	4	1,81	2,27	2,69	0,40	0,59	0,83	0,61	0,58
AS	0,20	0,25	0,33	1	1	1	7	8	9	1,12	1,26	1,44	0,25	0,32	0,44	0,34	0,32
AC	0,25	0,33	0,50	0,11	0,13	0,14	1	1	1	0,31	0,35	0,42	0,07	0,09	0,13	0,10	0,09
TOTAL										3,23	3,88	4,54				1,04	1,00

Table 7. The value of the comparison of the Stock alternatives (S)

S	SR	AS	AC
SR	1	5	9
AS	0,20	1	6
AC	0,11	0,166667	1

Table 8. Fuzzy Value Comparison of Stock alternatives (S)

S	SR			AS			AC			Value (Wi)			Fuzzy Weight (Wi)			Center of Area (Wi)	Normalised Weight
										1	2	3	1	2	3		
SR	1	1	1	4	5	6	9	9	9	3,26	3,51	3,73	0,63	0,73	0,84	0,73	0,72
AS	0,17	0,20	0,25	1	1	1	5	6	7	0,94	1,06	1,20	0,18	0,22	0,27	0,22	0,22
AC	0,11	0,11	0,11	0,14	0,17	0,20	1	1	1	0,25	0,27	0,28	0,05	0,06	0,06	0,06	0,06
TOTAL										4,46	4,84	5,22				1,01	1,00

4.4. Priority Determination

The results of the paired matrix calculation using fuzzy values found that the selling price criteria had the highest weight value (0.67), Demand (0.21), stock (0.11). So the determination of the main priority on this criteria is the Selling Price (SP). In addition, the alternative choice that has the highest weight is the Addition of Suppliers (AS) of 0.75. Therefore, the determination of the main alternative to the evaluation of the supply of chicken eggs is the addition of a supplier.

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4.5. SAFEA Software Development

The Fuzzy AHP usage model was developed through a SAFEA (Smart Application For Egg Agent) software where this software is a decision support tool to facilitate egg agent owners in assessing supplier performance. The owner of the Egg Agent can provide an assessment of the specified variables and this software and this software automatically provides information to the user to find out which variables are the main priority in assessing supplier performance. The display on the SAFEA software is presented in the following figure.

Figure 2. Pairwise Comparison Value Input Display

Figure 3. AHP Fuzzy Calculation Display

Figure 4. AHP Fuzzy Weighting Results Display

Figure 5. Display Description Main Priority Information Criteria

5. CONCLUCION

The Fuzzy AHP model approach for Egg Agents has three main criteria, namely egg stock in the warehouse, egg demand, and egg selling price and three alternative choices, namely supplier reduction, supplier addition, and consumer addition. From the results of the Fuzzy AHP calculation, it is found that the main priority as a decision supporter for the supply of chicken eggs is the selling price of chicken eggs to consumers, so that the alternative choice that is prioritized is the addition of suppliers to anticipate an imbalance between the number of eggs sold and the availability of stock in the warehouse.

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