

# Implementation of fuzzy logic to determining selling price of products in a local corporate chain store

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**Abstract.** Corporate chain store is one type of retail industries companies that are developing growing rapidly in Indonesia. The competition between retail companies is very tight, so retailer companies should evaluate its performance continuously in order to survive. The selling price of products is one of the essential attributes and gets attention of many consumers where it's used to evaluate the performance of the industry. This research aimed to determine optimal selling price of product with considering cost factors, namely purchase price of the product from supplier, holding costs, and transportation costs. Fuzzy logic approach is used in data processing with MATLAB software. Fuzzy logic is selected to solve the problem because this method can consider complexities factors. The result is a model of determination of the optimal selling price by considering three cost factors as inputs in the model. Calculating MAPE and model prediction ability for some products are used as validation and verification where the average value is 0.0525 for MAPE and 94.75% for prediction ability. The conclusion is this model can predict the selling price of up to 94.75%, so it can be used as tools for the corporate chain store in particular to determine the optimal selling price for its products.

**Keywords:** Corporate chain store, Fuzzy Logic, Selling price

## 1. Introduction

Retail industry is one type of industries that are developing growing rapidly in Indonesia. Competition among retail industries is very tight and the competition does not only occur among modern retail industries but also modern with the traditional retail. One example of retail industry is corporate chain store. Corporate chain store is a network of two or more stores owned and controlled jointly who make centralized purchasing and trading and sells similar product lines [11]. Corporate chain stores as modern retail industry have to compete with many other retail industries not only local and national, but also international. Corporate chain store X is one type of local chain stores in Yogyakarta area, where it is always trying to develop itself in order to survive in competition with other retail industries. It should evaluate its performance continuously in order to compete with the competitors. One aspect that is used to evaluate the performance of retail is consumer preferences aspects which include human resources, merchandise, and price. Human resource associated with the services provided, merchandise related to the number of products available, diversity of products, as well as the diversity of brands sold, whereas the price associated with a low price [3]. In the previous study [6] only discusses about merchandise aspect, namely how to determine the optimal product allocation from the central warehouse to each branch so the products required by the customer can be provided. Price is a very essential attribute and gets the attention of many consumers. Consumer put "low price" in the first rank among the top ten attributes of service for all commodities in the traditional and modern markets



[3]. Every retail try to sell their products at low prices but still provide optimum benefits. Many factors affect the retailers to determine their selling price so the pricing of the product is a quite difficult decision [1]. Factors affect the determination of the selling price is divided into two factors, namely cost factors and non-cost factors [5]. This research will specifically discusses about the determination of selling price by considering factors related to cost, namely the purchase price of the product from supplier, holding costs, as well as transportation costs. Result of this study is expected to provide tool in determining the optimal selling price.

## 2. Methods

Study case of this research is a local chain store "X" in the region of Yogyakarta. Model is built using fuzzy inference system especially fuzzy mamdani with the help of MATLAB R2008a software. Fuzzy logic approach is selected to solve the problem because this method can consider complexities factors. It has the potential of combining costs into selling price decision making. The step of this research starts with work activity identification and data collecting at PT.X. Input for the model is holding cost, transportation cost, and purchase price from supplier. Calculating holding cost is done by considering the costs involved in the process of storage product, such as cost of electricity, building cost, salary of employees, property taxes, damage cost, order cost, etc. Whereas transportation cost was calculated by considering shipment distance, maintenance cost, and fuel price. Next step is determining membership function and fuzzy rules to illustrate the relationship between the purchase price, holding cost, transportation cost, and selling price. The model is built by make changes to the membership function curve to obtain a smooth graph, where the selected membership function was gauss2mf and gbellmf because based on previous research both provide more optimal result than other forms. There are 27 rules are used, namely:

1. If purchase price "L", holding cost "L" and transportation cost "L" then selling price "L"
2. If purchase price "L", holding cost "L" and transportation cost "M" then selling price "L"
3. If purchase price "L", holding cost "L" and transportation cost "H" then selling price "M"
4. If purchase price "L", holding cost "M" and transportation cost "L" then selling price "L"
5. If purchase price "L", holding cost "M" and transportation cost "M" then selling price "M"
6. If purchase price "L", holding cost "M" and transportation cost "H" then selling price "M"
7. If purchase price "L", holding cost "H" and transportation cost "L" then selling price "M"
8. If purchase price "L", holding cost "H" and transportation cost "M" then selling price "M"
9. If purchase price "L", holding cost "H" and transportation cost "H" then selling price "M"
10. If purchase price "M", holding cost "L" and transportation cost "L" then selling price "L"
11. If purchase price "M", holding cost "L" and transportation cost "M" then selling price "M"
12. If purchase price "M", holding cost "L" and transportation cost "H" then selling price "M"
13. If purchase price "M", holding cost "M" and transportation cost "L" then selling price "M"
14. If purchase price "M", holding cost "M" and transportation cost "M" then selling price "M"
15. If purchase price "M", holding cost "M" and transportation cost "H" then selling price "H"
16. If purchase price "M", holding cost "H" and transportation cost "L" then selling price "M"
17. If purchase price "M" holding cost "H" and transportation cost "M" then selling price "H"
18. If purchase price "M", holding cost "H" and transportation cost "H" then selling price "H"
19. If purchase price "H", holding cost "L" and transportation cost "L" then selling price "M"
20. If purchase price "H", holding cost "L" and transportation cost "M" then selling price "M"
21. If purchase price "H", holding cost "L" and transportation cost "H" then selling price "H"
22. If purchase price "H", holding cost "M" and transportation cost "L" then selling price "M"
23. If purchase price "H", holding cost "M" and transportation cost "M" then selling price "H"
24. If purchase price "H", holding cost "M" and transportation cost "H" then selling price "H"
25. If purchase price "H", holding cost "H" and transportation cost "L" then selling price "H"
26. If purchase price "H", holding cost "H" and transportation cost "M" then selling price "H"
27. If purchase price "H", holding cost "H" and transportation cost "H" then selling price "H"

\* *L= Low, M= Medium, H= High*

Selling price is output from this data processing. Validation model is done towards four products namely Maya Sardines Chili 155 g, Fortune Refill 1lt, Happytos Real Corn Chips/Red 170 g and Cap Lang MKP 30 ml.

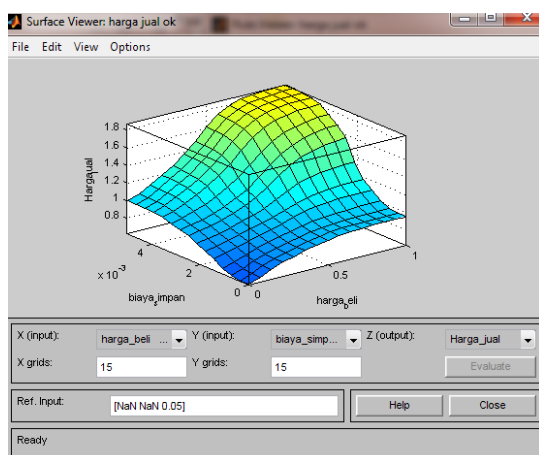
### 3. Result and Discussion

Costs that were used as inputs to obtain the selling price were purchase price, holding cost, and transportation cost. Table 1 shows the result of costs calculation that were used to build the model.

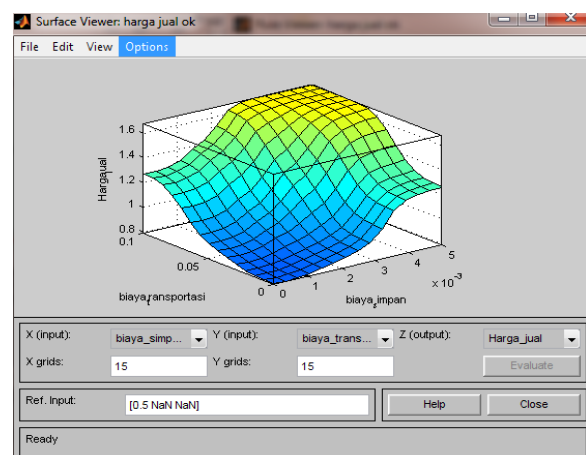
**Table 1.** Data Input

Product	Purchase Price/pcs (Rp)	Holding Cost /pcs (Rp)	Transportation Cost /pcs (Rp)
Blue Poci Tea 40 g	1517	9.074	85.020
Tea Box Sosro 200 ml	1850	1.759	212.549
Red Happytos	6700	14.731	318.824
Prenagen Mommy Cocholate 200 g	32225	6.221	850.197
Honey Chil Kid 200 g	30475	7.165	850.197
Cap Lang MKP 60 ml	10396	9.330	87.951
Indocafe Coffeemix 20 g Sachet	883	0.612	9.109
Vanilla Poci Tea Bag 10*5*25 S	3450	2.893	221.791

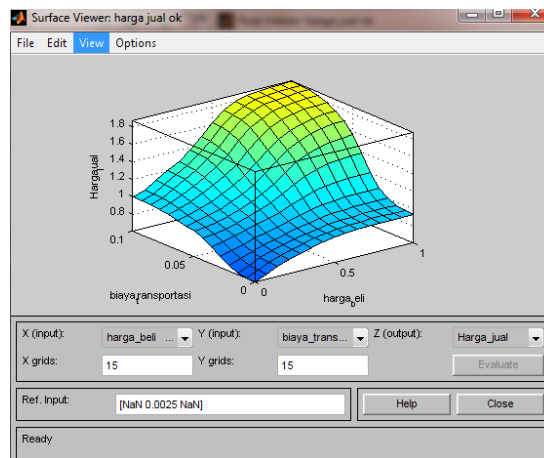
That costs be normalized to the total sum of all costs, so the numbers were put into fuzzy input was the cost that has been normalized. Costs should be normalized to determine the applicable range for a characteristic variable in this design. If the range is too small or too large may have impact on the overall system performance. It is a temptation to have wide membership functions on the right or left to capture the extreme input values.



**Figure 1.** Relationship between purchase price, holding cost, and selling price



**Figure 2.** Relationship between transportation price, holding cost, and selling price



**Figure 3.** Relationship between transportation price, purchase price, and selling price

Changes to curves are intended to produce a better model seen from the graph, MAPE and predictive ability. The curve shows that if purchase price is high so the selling price is also high. Likewise also to holding cost and transportation cost, if the holding cost and transportation cost are high, value of the selling price is also high. Based on the rules that have been made and the limits of the universe of discourse namely value of variables are used, then obtained the optimal graph model that describes the relationship between the purchase price, holding cost, transportation cost, and selling price. They are shown in Figure 1, 2, and 3.

The model should be validated and verified. Validation is done by calculating the MAPE whereas verification is done by calculating predictive ability for some products that not include in process making the model. MAPE is calculated based on formula (1).

$$\text{MAPE} = \frac{\text{ABS}(Y - Y')}{Y} \quad (1)$$

Description:

MAPE = Mean Absolute Percentage Error

Y = selling price

Y' = selling price of fuzzy logic result

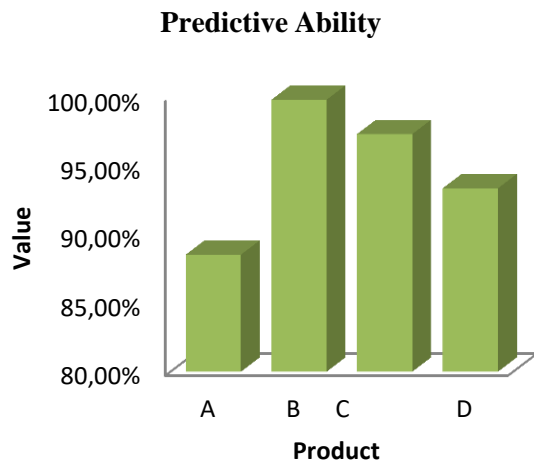
Predictive ability is obtained by formula (2).

$$\text{Predictive ability} = 1 - \text{MAPE} \quad (2)$$

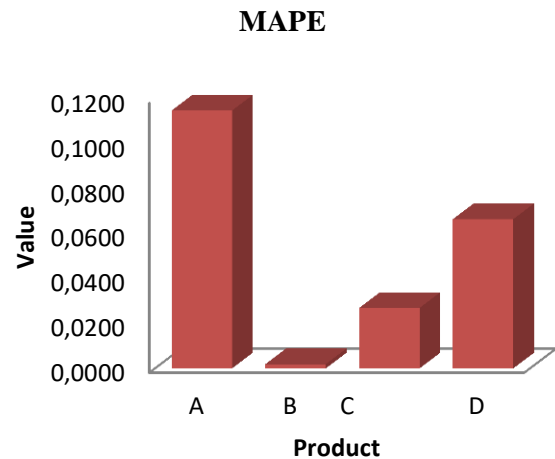
Result of calculating MAPE and prediction ability of 4 products is shown in Figure 4 and Figure 5. Based on these calculations, the average value of predictive ability is 94.75%. This value is high enough, so this model can be used to determine selling price of product.

There are some differences in fuzzy logic prediction ability for every product. It is because the different pattern of sales the product, but the average ability of the model prediction have been built is high enough because fuzzy logic can combine the various possibilities in its Fuzzy Inference System (FIS), such as combination of curves, combination of rules, and change the curve shifts. However, this fuzzy model still has deficiency that because of the limits of universe of discourse is used, so that if the input value is entered outside from the universe of discourse, the result is not necessarily valid. In

addition, the process to determine the rules and FIS in producing the best model takes a long time. So if the variable is used more and more, the time required to obtain the optimal model also will be longer.



**Figure 4.** Value of predictive ability



**Figure 5.** Value of MAPE

Description:

A = Happytos Real Corn Chips 170 g

B = Fortune Refill 1 l

C = Cap Lang MKP 30 ml

D = Maya Sardines Chili 155 g

#### 4. Conclusions

Model of determining the selling price of product has been produced by using fuzzy logic method. Fuzzy model has three inputs namely purchase price, holding cost, transportation cost, and one output namely selling price. Each input and output has three fuzzy set. They are Low (L), Medium (M), and High (H). There are twenty seven rules that are used, they are combination of input and output fuzzy membership function. Model validation was done by calculating the MAPE and the ability of the model prediction, where the average value is 0.0525 and 94.75%. Therefore, fuzzy model that has been built can predict the selling price of up to 94.75%, so it can be used as tools for the corporate chain store in particular to determine the optimal selling price for its products.

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