# Inventory Level Optimization of Raw Materials for Ready-Made Garment Industry XYZ Pty Ltd using Mamdani Method of Fuzzy Interference System

**N Nurhasanah[1], SW Fauzia[1], B Aribowo[1], R Safitri[2], B Samiono[3], CF Lutfia[1], M Devana[1], P Kalifa[1], A Supriyanto[2]**

[1]Industrial Engineering Department, Faculty of Science and Technology, Universitas Al Azhar Indonesia, Sisingamangaraja Street, Jakarta 12110, Indonesia
[2]Informatic Engineering Department, Faculty of Science and Technology, Universitas Al Azhar Indonesia, Sisingamangaraja Street, Jakarta 12110, Indonesia
[3]Management Department, Faculty of Economy, Universitas Al Azhar Indonesia, Sisingamangaraja Street, Jakarta 12110, Indonesia
nunungnurhasanah74@gmail.com, syitawf@gmail.com

**Abstract**. Every company who performs production activities needs inventory of raw materials. The most important thing which is mandatory for all companies when performing their production activities is management of inventory, as inventory is an asset for a company. Availability of raw materials in the industry is expected to facilitate production/service activities to meet consumer needs. Ready-made garment industry, XYZ Pty Ltd is a family business established in 2004 located in Jakarta which engages in textile manufacture and has shown a relatively high demand. While XYZ Pty Ltd attempted to meet the demand, the inventory level was not able to balance with it, resulting in after-hour work of employees. In order to provide appropriate solutions, we proposed some strategies using Mamdani method and TFN (Triangular Fuzzy Number) range which selected appropriate rules to optimize inventory level of the company. Average of range score Fuzzy Interference System obtained for both production level and demand level were 36,500, while average of range score Fuzzy Interference System obtained for Inventory Cost and Inventory Level were 2,250,000,000 and 13,900, respectively. Rules resulting in a high inventory level are very good for use either together with other levels or not. Rules resulting in an intermediate inventory level are also good for use, in particular together with low and intermediate demand levels. Rules resulting in a high demand level are still good for use. On the other hand, rules resulting in a low inventory level are not good for use.
**Keywords**: Inventory, Demand, Production, Optimization, Ready Made Garment, Fuzzy Inference System

## 1. Introduction

In order to obtain a quality production, a company pays attention to details of manufacturing activities. Management of inventory is essential for a company, considering that inventory is a company's asset. Availability of raw materials allows production process running in accordance with consumer needs. In addition, an adequate availability of raw materials in warehouse is expected to facilitate production/service activities to meet consumer needs. This importance was also recognized by a ready-made garment industry, XYZ Pty Ltd. The problem dealt with by XYZ Pty Ltd currently was inexistence of production plan as production still relied on market demands which were fluctuating. Due to inexistence

of a production planning system, demands might sometimes be higher which was not balanced with the inventory level. Using Fuzzy Logic Mamdani method, a number of rules, such as low, intermediate, and high production levels and costs, were determined that ensured inventory level to meet demand level **[1]**.

## 2. Methods

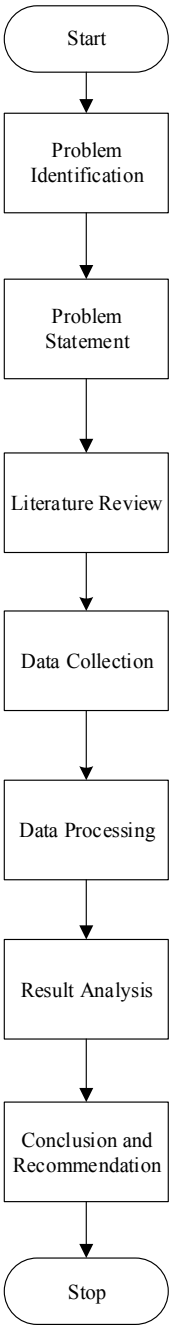


**Figure 1.** Research Methodology

First step carried out in this study was identifying problems in production activities of XYZ Pty Ltd. Problem statement was composed based on the existing problems found. Type of literature study used was determined subsequently, which was Mamdani method and TFN (Triangular Fuzzy Number) range. Data collection was performed from production level, demand level, inventory costs, and inventory level. Data processing was carried out to obtain rules which were applied in Mamdani method. The results

obtained from data processing were analyzed, and conclusion was drawn while recommendation was given to XYZ Pty Ltd.

## 3. Results and Discussion

### 3.1 Fuzzy Analytic Hierarchy Process

F-AHP (Fuzzy Analytic Hierarchy Process) is a ranking method in decision making which incorporates different criteria. In order to determine variable weights in F-AHP, a function rule in the form of Triangular Fuzzy Number (TFN) which was arranged according to a linguistic set was employed [2].

In defining values of AHP intensity into Triangular Fuzzy Number (TFN) scale, each fuzzy set was divided by two, except that intensity of importance was divided by 1, according to [3] in his definition on F-AHP. Triangle Fuzzy scale used by Chang is given in Table 1 [4].

**Table 1.** Fuzzification of Comparison between 2 Criteria [3]

| Definition | Likert Scale | TFN | Invers Fuzzy Scale |
|---|---|---|---|
| Equally Important | 1 | (1, 1, 1) if diagonal (1, 1, 3) if others | (1/1, 1/1, 1/1) if diagonal (1/3, 1/1, 1/1) if the opposite |
| Slightly More Important | 2 | (1, 2, 4) | (1/4, 1/2, 1/1) |
| | 3 | (1, 3, 5) | (1/5, 1/3, 1/1) |
| | 4 | (2, 4, 6) | (1/6, 1/4, 1/2) |
| More Important | 5 | (3, 5, 7) | (1/7, 1/5, 1/3) |
| | 6 | (4, 6, 8) | (1/8, 1/6, 1/4) |
| Extremely More Important | 7 | (5, 7, 9) | (1/9, 1/7, 1/5) |
| | 8 | (6, 8, 9) | (1/9, 1/8, 1/6) |
| Absolutely More Important | 9 | (7, 9, 9) | (1/9, 1/9, 1/7) |

Fuzzification scale of comparison between two criteria was described in a graph, as given in Figure 2 [4].

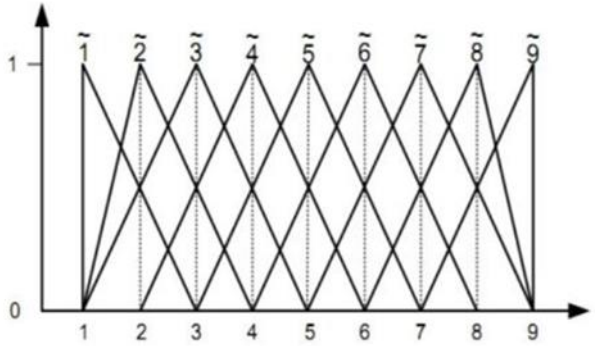


**Figure 2.** Fuzzification graph of F-AHP scale [3]

### 3.2 TFN (Triangular Fuzzy Number) Range

TFN (Triangular Fuzzy Number) range is quantitative data which shows [4] highest and lowest values. This study used range for production level, demand level, inventory cost, and inventory level at X Pty

Ltd. The range of values obtained from interviews with an expert, where the results for the production level and the lowest demand level were 26,000 dozen and the highest was 47,000 dozen, the value range for the lowest inventory cost is 1.5 billion and the highest is 3 billion, and value range for the lowest inventory level of 9,288 dozen and the highest of 18,577 dozen. TFN (Triangular Fuzzy Number) range is presented in Table 2.

**Table 2.** TFN (Triangular Fuzzy Number) range

| **TFN (Triangular Fuzzy Number) Range** | | | |
|---|---|---|---|
| **No** | **Description** | **Lowest** | **Highest** |
| 1 | PL (Production Level) | 26,000 dozens | 47,000 dozens |
| 2 | DL (Demand Level) | 26,000 dozens | 47,000 dozens |
| 3 | IC (Inventory Cost) | 1.5 billions | 3 billions |
| 4 | IL (Inventory Level) | 9,288 dozens | 18,577 dozens |

3.3 Rules of Fuzzy Interference System

In this step, determination of rules of Fuzzy Interference System was made from opinion of experts, resulting in 27 rules which would be processed using Fuzzy Logic Mamdani on Matlab software [5]. The obtained rules are presented in Table 3.

**Table 3.** Rules of Fuzzy Interference System

| **No** | **PL** | **DL** | **IC** | **IL** |
|---|---|---|---|---|
| 1 | H | H | H | H |
| 2 | H | H | M | H |
| 3 | H | H | L | H |
| 4 | H | M | H | M |
| 5 | H | M | M | M |
| 6 | H | M | L | M |
| 7 | H | L | H | H |
| 8 | H | L | M | H |
| 9 | H | L | L | L |
| 10 | M | H | H | M |
| 11 | M | H | M | H |
| 12 | M | H | L | M |
| 13 | M | M | H | M |
| 14 | M | M | M | M |
| 15 | M | M | L | M |
| 16 | M | L | H | L |
| 17 | M | L | M | L |
| 18 | M | L | L | L |
| 19 | L | H | H | H |
| 20 | L | H | M | H |
| 21 | L | H | L | H |

| | | | | |
|---|---|---|---|---|
| 22 | L | M | H | M |
| 23 | L | M | M | M |
| 24 | L | M | L | L |
| 25 | L | L | H | L |
| 26 | L | L | M | L |
| 27 | L | L | L | L |

3.3.1 Matlab Software for Fuzzy Logic Mamdani

In performing Matlab Fuzzy Logic Mamdani, data TFN (Triangular Fuzzy Number) range and the obtained rules had to be inputted. Steps of Matlab software use in this study is as follows [6].

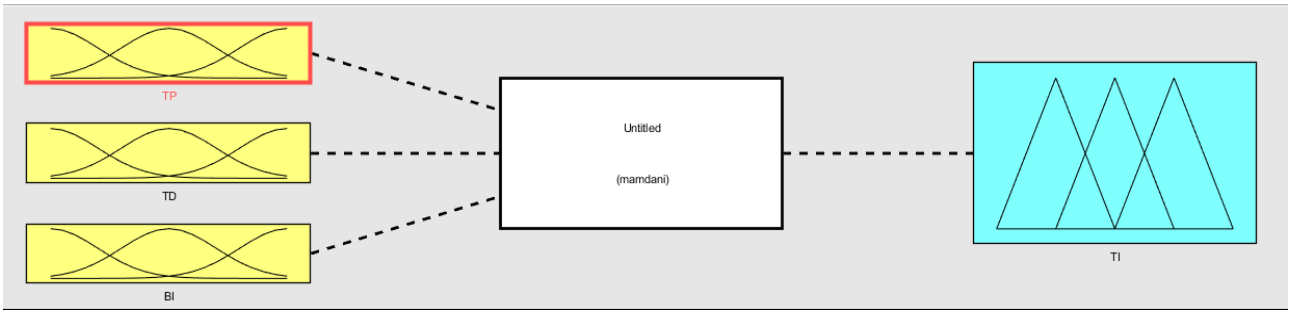


**Figure 3.** Determination of Input

The first step to perform was selection of Fuzzy Logic Mamdani, followed by completing Input and Output. In this research, we had 3 inputs, including Production Level, Demand Level, and Inventory Cost, as well as 1 output, namely Inventory Level.

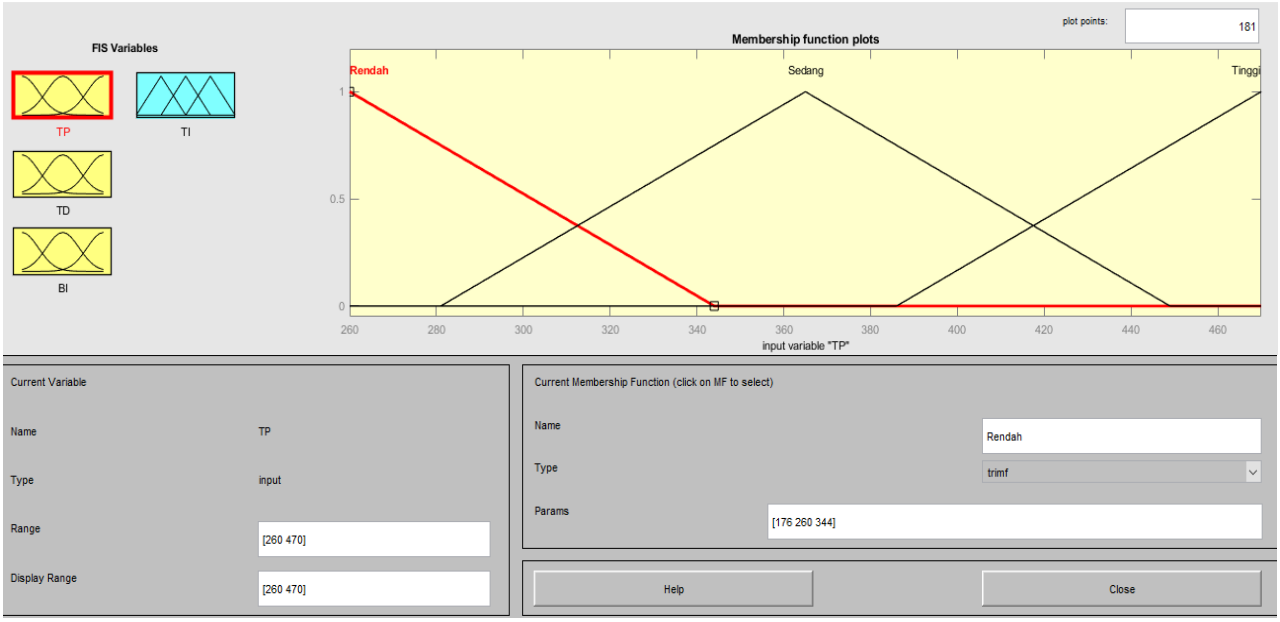


**Figure 4.** Determination of Range for Each Criteria

The next step was completion range of each criteria by filling out low, intermediate, and high rules of each criteria.

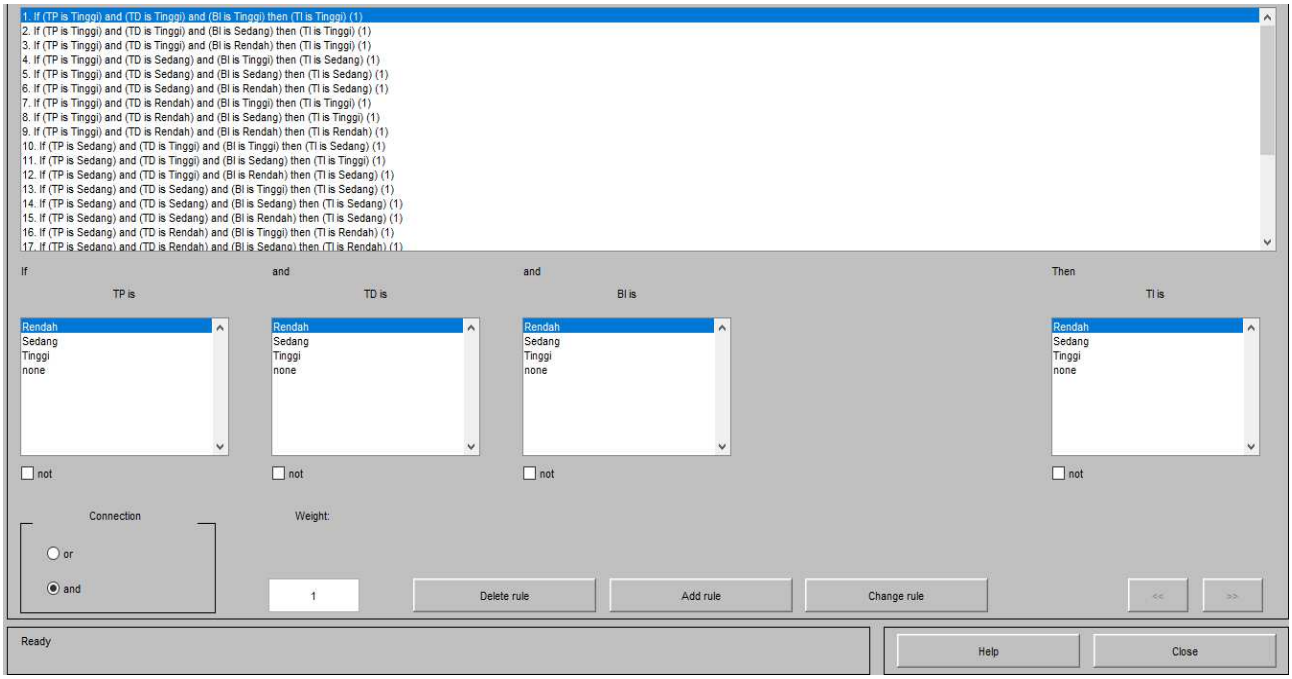


**Figure 5.** Range Input

After filling out range and criteria, we moved to the third step, in which the 27 rules were inputted into Matlab.

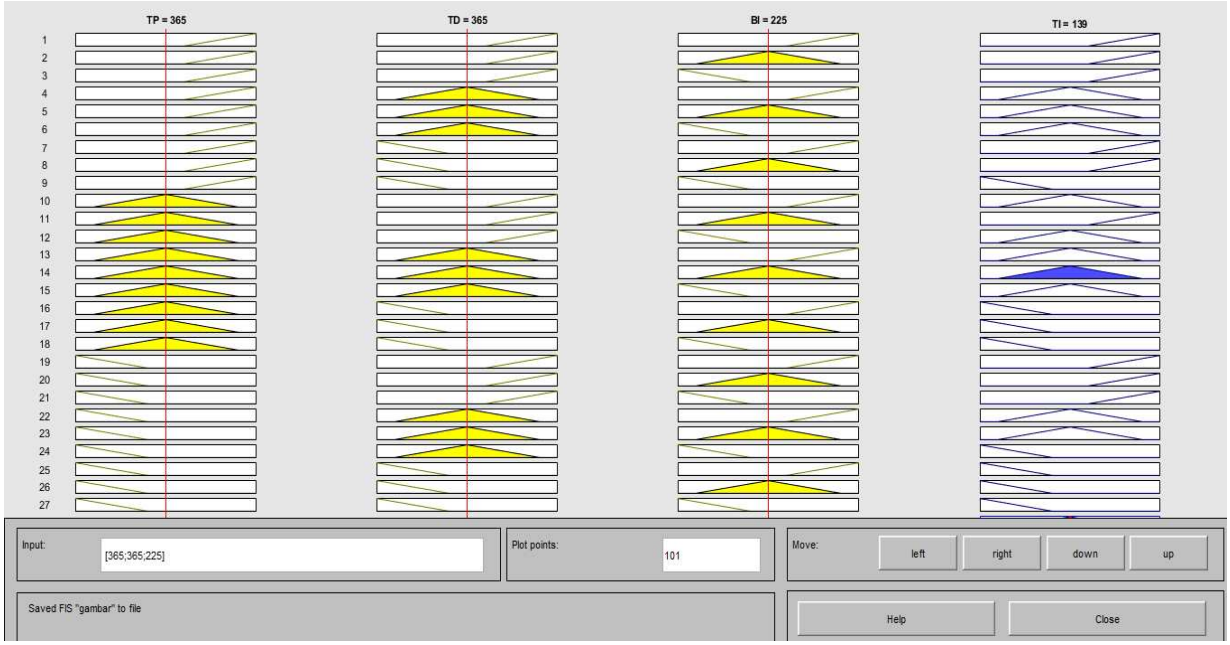


**Figure 6.** Results from Fuzzy Interference System

Figure 6 shows that rules number 9, 16, 17, 18, 24, 25, 26, and 27 had a low Inventory Level (IL), and therefore they were not able to be used. Rules number 4, 5, 6, 10, 12, 13, 14, 15, 22, and 23 had an intermediate Inventory Level (IL), and therefore they were still considerable for use. Moreover, a high inventory level as shown by rules number 1, 2, 3, 7, 8, 11, 19, 20, and 21 was good for use as through a high inventory level, demand level (DL) is able to be met at different production levels and cost levels. Average of range score Fuzzy Interference System obtained for PL, DL, IC, and IL were obtained for both production level and demand level were 36,500, while average of range score Fuzzy Interference System obtained for Inventory Cost and Inventory Level were 2,250,000,000 and 13,900, respectively.

## 4. Conclusion

Based on the experiment on Fuzzy Interference System using Matlab Software in order to investigate Inventory Level of XYZ Pty Ltd, it was concluded that:

1. The average value of the Fuzzy Inference System range is the Production Level of 36500, the Demand Level of 36500, the Inventory Cost of 2250000000, and the Inventory Level of 13900. The value is obtained using the matlab software.
2. Rules with high inventory levels are very good to use, because they can meet the demand level with low, medium and high conditions.
3. Rules with good inventory levels are used, especially with small and medium demand levels. While with a high level of demand, these rules can still be used.
4. Rules with low inventory levels are not good to use, because they cannot meet medium and high demand levels.

**5. Acknowledgement**
Thanks to Directorate of Research and Community Service of the Ministry of Research and Technology of the Republic of Indonesia which funded this research activity in 2018 with an Applied Product Research scheme.

**6. References**

[1] E. Mamdani, Application of Fuzzy Logic To Approximate Reasoning Using Linguistic Synthesis, London: Queen Mary College, London University, 1975.

[2] L. A. Zadeh, "Fuzzy Sets," *Information And Control,* vol. VIII, pp. 338-353, 1965.

[3] D. Y. Chang, "Application of The extent Analysis Method On fuzzy AHP," *European Journal of Operational Research,* pp. 649-655, 1996.

[4] Y. M. Wang and K. S. Chin, "Fuzzy Analytic Hierarchy Process: A Logarithmic Fuzzy Preference Programming Methodology," *International Journal of Approximate Reasoning,* p. 13, 2010.

[5] A. H. Prihamayu, "Mamdani Method Fuzzy Logic Application in Deciding the Amount of Production Decision," p. 10, 2015.

[6] A. Naba, Belajar Cepat Fuzzy Logic Menggunakan MATLAB, Yogyakarta: ANDI, 2009.