

Megi Saputra

by sunanmuhammat@gmail.com 1

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Prediction of Car Sparepart Sales Using the Web Based Mamdani Fuzzy Method at RD-Variasi Stores

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^{1*}Megi Saputra, ²Ahmad Habib. S.Kom., M.M.

^{1,2,3}Teknik Informatika, Universitas 17 Agustus 1945 Surabaya

E-mail: ¹migisaputra06@gmail.com, ²habib@untag-sby.ac.id

Abstract— Technological advances in this modern era have developed very rapidly, one example is information systems. An information system using a web base is one of the important points for gathering information. And even in this era, which person doesn't know about car repair shops or car spare parts shops. RD Variation is a car spare parts store located in Tingal Village, Garum District, Blitar Regency. RD Variation has been open for about 8 years, and the purpose of this research is to predict sales of goods in stores, so that stores can stock goods regularly, then the store does not run out of stock during sales. And in the end, the buyer believes, because the stock is always there and the shop can be relied on. The research has been reset to a shortage of stores, that is, they always run out of stock of goods during sales, which will apply a Sales Prediction Information System Using the Fuzzy Mamdani Method to RD Variasi Stores.

Keywords – Information Systems, *Fuzzy Mamdani*



Corresponding Author:

Author [],
Department [],
Institution [],
Email []



I. INTRODUCTION

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Along with the rapid development of the business world, the existence of information technology based on the web is very influential on aspects of work. For large companies, there may be many who use information systems to meet company needs, you might say that information systems are an important role in a company. [1] The Spare Part Shop called RD Variasi is a Car Spare Parts shop that sells various kinds of car-related items, such as LED variations, audio, window film, bumpers and many more. The store has been selling for about 8 years. The store uses a system if the stock runs out and then produces goods, so the store does not produce regularly every month. The constraints that exist in this spare part store are the process of ordering goods and picking up goods which are often not on time, causing problems such as overdemand and oversupply of goods in the RD Variasi warehouse.

This research was conducted by the researcher to help solve the problem of stock items at the Sapre Part RD Variasi Kab. Blitar, the shop is a car spare parts store that is quite large and well known in the city of Blitar, because manual stocking sometimes makes it confusing to buy goods, which sometimes existing stock is bought back while stocks that are not available are not purchased, the author chooses to make it salastu problem to be researched.

From the results of a survey that has been conducted by researchers, researchers can assist in solving problems that exist at the RD Variasi Store, by looking at the results of sales data from last year, researchers can conclude to create an information system, to predict the stock of goods to be purchased at next month. This prediction information system uses the fuzzy mamdani method to solve the system where the method uses Min Max and is easy to understand.[2][3]

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In previous studies that referred to the analysis of the application of a fuzzy interface system using the Mamdani system to predict the supply of goods. This research was carried out to make more accurate forecasting, so we need a method that can calculate the uncertainty that occurs, in this case the method used is to use the Mamdani Fuzzy inference system to forecast the number of requests for the supply of goods based on the number of sales, inventory and crowd levels. visitors every day. [4] The results of the study stated that from the forecast results with the realization, the difference is obtained if using a single moving average, namely 597 units at the lowest point and 790 units at the highest point or 6.0% - 7.9% for a three-month period, and 30 units at the lowest point and 427 at the highest point or 0.3% -4.3% in a three month period if using a double moving average.

The second study refers to the method of forecasting Shopee consumer interest in the coming year. One of the analytical methods for forecasting that is well known is the Fuzzy time series method. The fuzzy time series used is Chen's method.[5]

To overcome problems related to predictive information management, stock items in the RD Variasi store. So it is necessary to build a predictive information system that can manage inventory. The Mamdani fuzzy method has a mathematical concept behind fuzzy reasoning. very simple and easy to understand, very flexible, tolerates imprecise data, the results of research that calculate the Mamdani fuzzy method have a lower error rate compared to the method and Sugeno in terms of predictions.[6] Therefore it is hoped that the existence of an application system using the fuzzy mamdani method can provide opportunities for companies to predict the amount of inventory because it is faster than using Microsoft Excel. [7]

The least squares method is a forecasting method that determines a linear relationship from past data with predictions of future data. This method is used to predict periodic data because the calculation is more accurate. The least squares method is suitable for time series analysis and differs from the a priori method used to determine relationships between data. [8] In this study it is not only focused on connecting data, but also to predict sales of goods at the Rd Variasi store.

In the next study, they were both engaged in selling spare parts but used the Weight Moving Average and Reorder Point methods for their forecasting system. the Weight Moving Average (WMA) method is good enough to be applied in inventory forecasting and can be combined with the Reorder point method for determining inventory safety limits. The update of this research is that apart from the combined use of WMA and ROP methods, a system is also created in which data sources for WMA and ROP calculations are obtained from the process of importing data directly from periodic transactions.[9] For software development using the waterfall method. The waterfall model is used because of the ease in analysis, design and implementation. The wight moving and reorder point methods can also be used as a reference and applied in this study.[10]

In the next reference entitled "Apparel Production Prediction Using the Fuzzy Mamdani Method (CMS Production Case Study)" CMS Production Pontianak is a clothing store that sells long shirts, short shirts, raglan shirts, jackets and hats. Cropped, long and raglan t-shirts are among the items most sought after by consumers. The problem that arises is production exceeds market demand, increasing production costs and causing store losses. To overcome this, we need a clothing production forecasting system that allows stores to predict easily next month's clothing production. In this study, the authors implemented a clothing production forecasting system using

the website-based Mamdani fuzzy method by applying demand, sales, and supply parameters. Usage data is on-demand, sales, and inventory data for each garment from February to November 2019. System testing is carried out by calculating the error value between system results and real data using Mean Absolute Percentage Error (MAPE). The percentage of success of the Mamdani fuzzy method in predicting clothing production using 30 clothing data for each type of clothing, namely, for short t-shirt types is 91.5%, long t-shirt types are 90.91% and raglan t-shirt types are 90.80% and the result of predicting sales value in predicting clothing production with a minimum value of 310 and a maximum of 435 short shirts is 93.05%, long shirts (220-315) are 91.29% and raglan shirts (200-260) are 90.30%.[11]

II. RESEARCH METHOD

2.1. Research Logi Method

In the research flow of the process of making this prediction information system, it can be seen in Figure 2.1 which includes the following sections.

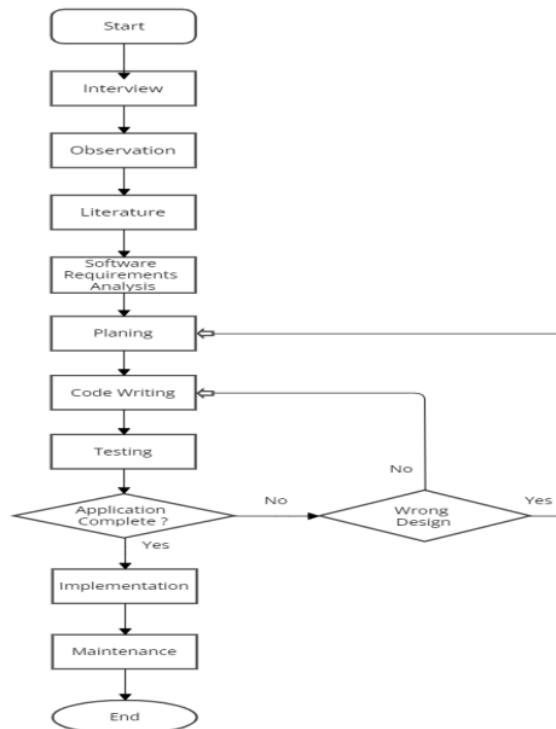


Image 2.1 Flowchart

2.2. Fuzzy Logic

Fuzzy logic was first introduced by Lotfi A. Zadeh in his work on fuzzy set theory in 1965. Lotfi Asker Zadeh is an Iranian-American researcher at the University of California at Berkeley.

Fuzzy logic or fuzzy logic in English is a form of multi-valued logic that has a variable truth value as a real number between 0 and 1. Fuzzy logic is used in artificial intelligence systems to mimic human reasoning and thinking. Fuzzy logic is a further development of binary logic. Binary logic only has 2 truth values, namely 0 or 1. Fuzzy logic contains 0 and 1 as extreme truth values, but with different truth interval levels. [12]

a. Rule Base

Contains all the "if-else" rules and conditions to control decisions. However, with modern developments, the number of rules used by fuzzy logic has decreased significantly. [13]

b. Fuzzycation

Fuzzy is another component of the fuzzy logic architecture and is useful for manipulating input. This component helps convert extreme numbers into fuzzy sets. Extreme inputs are measured by sensors and passed to the control system for processing. This module is used to change the system input and also helps separate the input signal into five states, namely, big plus, medium positive, small, negative average, and big minus.. [14]

c. Defuzzykasi

This module is the opposite of fuzzing. Here the fuzzy values are changed to extreme values by mapping. There are several defuzzification methods for this, but the selection of the best method is based on the input.

The methods used in de-fuzzification are the median method and the midpoint interval method, which are used to make the right decision.

- Himpunan Fuzzy

Fuzzy logic is based on fuzzy set theory. In fuzzy set theory, the role of membership is a key factor in determining whether an element is in a set.[15]

- Fungsi Keanggotaan

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- Representasi Linear

In the linear representation, the mapping of inputs to degrees of membership is depicted as a straight line. This shape is the simplest and a good choice of approach a concept that is not clear.

There are 2 states of a linear fuzzy set, consisting of an increasing and decreasing Linear Representation. The rising state of the fuzzy set starts at the dominant value which has a membership degree of zero [0] and moves to the right towards the domain value which has a higher degree of membership.[15]

2.3. Metode Fuzzy Mamdani

The Fuzzy Logic Mamdani method is operating system software that can support the use of Microsoft Visual Studio 2010, web servers, database management systems (DBMS), and browsers.. [16]

Company problems are solved by calculating mamdani fuzzy logic, starting with the formation of fuzzy sets, implicit function implementation, rule composition and defuzzification. Based on Mamdani's fuzzy logic steps, a data sample is needed to calculate the forecast for the number of goods to be produced.[16]

Formation of Fuzzy Sets

The nature of the formation of fuzzy sets in this problem is :

1. Demand Variables [1]
2. Product Sold Variable
3. Inventory Variable
4. The composition of the rules

2.4. Defuzzykasi Mamdani

Defuzzification is the opposite of fuzzyfication, namely mapping from fuzzy sets to strict sets. The input of the defuzzyfication process is a fuzzy set obtained from the composition of fuzzy rules. The result of this defuzzyfication is the output of the fuzzy logic control system. Defuzzification is described as.[14]

2.5. Sistem Infomasi

Information systems are systems that can be defined by collecting, processing, storing, analyzing, disseminating information for specific purposes. Like any other system, an information system consists of inputs (data, instructions) and outputs (reports, calculations).. [17]

2.6. Prediksi

Prediction is the process of forecasting a variable in the future based more on intuitive considerations than past data although it places more emphasis on intuition, in Price predictions also often use quantitative data as complementary information in forecasting.[18]

2.7. Mape

Mape are a way to determine the size of the error in a model's time series data, as well as to distinguish estimated values from true values. MAPE is often used to calculate the average level of absolute error. [19]

2.8. Software Development Methods

The method used in this study uses the waterfall method, which aims to minimize errors that may occur, because starting from the analysis, design, coding, testing and support stages, this method is sequential and must wait for the completion of the previous stage. [20]

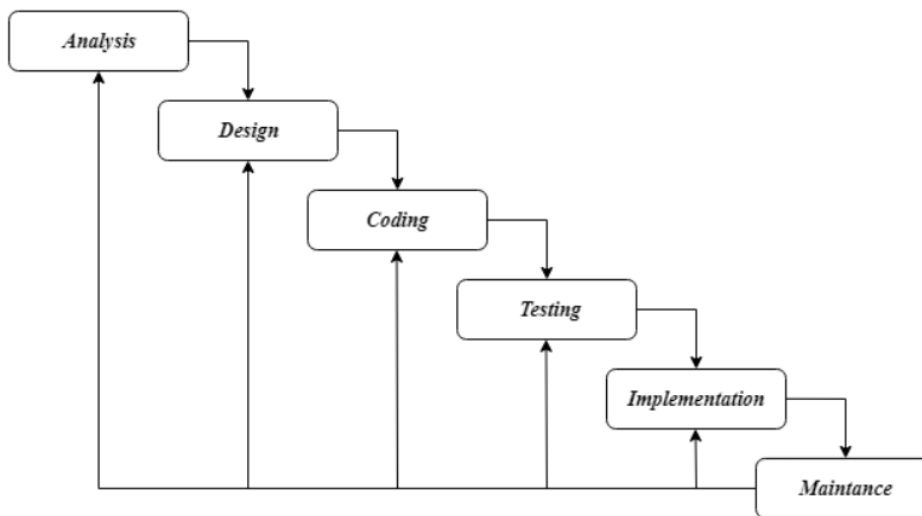


Image 2. 2 Metode Waterfal

III. RESULT AND DISCUSSION

From the results of research on existing data at the Rd Variation store, sales results are erratic every month. Sometimes spare part shops can sell more than 20 audio boxes per month when there are lots of buyers. But when it's quiet, the number of buyers can be less than 15 pieces.

Data analysis is a technique for collecting data during research. Data collection and processing aims to obtain data that is relevant to the research objectives, so that the results and output do not endanger the research objectives. [21] Data collection is carried out through observation and survey techniques, with the aim of determining the amount of stock items and quantities

requested. By implementing the Mamdani Fuzzy Method, the RD Variation Store is able to predict the number of items to be sold based on the number of requests received. [22]

3.1. Requirement Specification

- **Functional Requirement** is a type of requirement that contains processes that will be carried out by the system, besides that it contains information that must exist and be produced by the system. Functional requirements have several requirements, namely activities that must be carried out in the system, based on business procedures and functions, and documented in the model. Functional requirements include both hardcopy and softcopy reports, updating data, storing data, and searching data.[23]
- **Functional Non Requirement** are service or function constraints offered by the system such as time constraints, process development constraints, standardization etc. In other languages, non-functional requirements are requirements that focus on the behavioral properties of the system. Functional requirements are also often referred to as service or function boundaries offered by the system such as time constraints, process development limitations, standardization and others. [24]

Fuzzy Mamdani System Design

At this stage, the design of the Mamdani fuzzy system is carried out after the data is obtained. Based on the Fuzzy Mamdani method, there are several steps to determine the output before entering into the calculation. [25]

Tabel 3. 1 Data Training

Month	Year	Request	Sale	Supply	Production
January	2022	150	195	151	125
February	2022	250	200	124	512
March	2022	350	292	124	241
April	2022	450	250	512	522
May	2022	550	120	421	713
June	2022	155	140	124	123
July	2022	152	152	532	123
Agusts	2022	159	181	512	412
September	2022	172	125	124	412
October	2022	176	125	212	532
November	2022	192	422	123	252
December	2022	177	221	432	532
January	2023	210	124	123	123
February	2023	201	214	124	436

March	2023	200	231	412	124
	MIN	150	120	123	123
	MAX	550	422	532	713
	MEAN	192	195	151	412

3.2. Fuzzy Variable Definition

At this stage, by paying attention to the interview data, the membership values determined from the current supply, sales, and demand are taken using the membership function of the fuzzy set. The shape of the fuzzy rules of the two input variables and the output variables are determined by analyzing the data against the limits of each fuzzy set on each variable, so there are 8 fuzzy rules that will be used in this system, with the result that:

Table 3.2 Date Variable

No	Variable			
	Request	Sale	Supply	Production
1	Currently	Currently	Currently	Reduce
2	Currently	Currently	Lots	Reduce
3	Currently	Go On	Currently	Increase
4	Tall	Go On	Lots	Reduce
5	Tall	Currently	Currently	Increase
6	Tall	Currently	Lots	Reduce
7	Tall	Go On	Currently	Increase
8	Tall	Go On	Lots	Increase

Here's how to get membership values based on the numerical and linguistic variables used:

$$\mu(x)_{LOW} = \begin{cases} 1; & x \leq 150 \\ \frac{192-x}{192-150}; & 150 \leq x \leq 192 \\ 0; & x \geq 192 \end{cases} \quad (4)$$

$$\mu(x)_{CURRENTLY} = \begin{cases} 0; & x \leq 150 \text{ or } x \geq 550 \\ \frac{x-150}{192-150}; & 150 \leq x \leq 192 \\ \frac{550-x}{550-192}; & 192 \leq x \leq 550 \end{cases} \quad (5)$$

$$\mu(x)_{TALL} = \begin{cases} 0; & x \leq 192 \\ \frac{x-192}{550-192}; & 192 \leq x \leq 550 \\ 1; & x \geq 550 \end{cases} \quad (6)$$

Fuzzy set membership function LOW, MEDIUM, HIGH From Request variable.

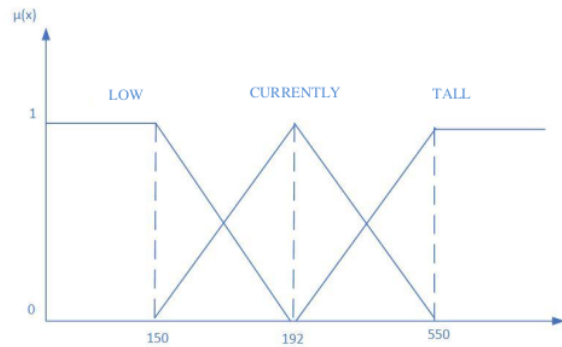


Image 3.1 Chart Fuzzy

$$\mu(y)_{LOW} = \begin{cases} 1; & y \leq 123 \\ \frac{155 - y}{155 - 123}; & 123 \leq y \leq 155 \\ 0; & y \geq 155 \end{cases} \quad (7)$$

$$\mu(y)_{CURRENTLY} = \begin{cases} 0; & y \leq 123 \text{ or } y \geq 532 \\ \frac{y - 123}{155 - 123}; & 123 \leq y \leq 155 \\ \frac{532 - y}{532 - 155}; & 155 \leq y \leq 532 \end{cases} \quad (8)$$

$$\mu(y)_{TALL} = \begin{cases} 0; & y \leq 155 \\ \frac{y - 155}{532 - 155}; & 155 \leq y \leq 532 \\ 1; & y \geq 532 \end{cases} \quad (9)$$

Fuzzy set membership function LOW, MEDIUM, HIGH From Request variable.

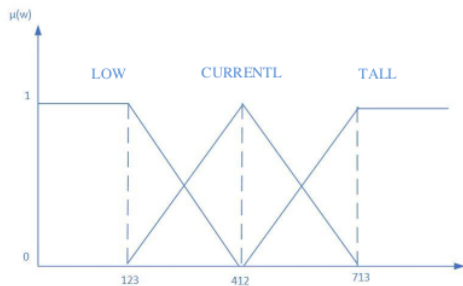


Image 3.2 Chart Fuzzy

Testing

The testing phase is to determine product production predictions, and this test uses the previous month's sample data to get the next month's production forecast. In this experiment, the author will explain how to test by entering sample data collected from observation locations by inputting it into a system that has been made for a known amount of production and testing this by using black box testing to test the accuracy of this system.

Fuzzy Variable Definition

Table 3.3 Variable Fuzzy

Linguistik	Numerik	Satuan
PrmRendah	150	Kasur/Bulan
PrmSedang	192	Kasur/Bulan
PrmTinggi	550	Kasur/Bulan
PsdRendah	123	Kasur/Bulan
PsdSedang	151	Kasur/Bulan
PsdTinggi	532	Kasur/Bulan
PnjlRendah	120	Kasur/Bulan
PnjlSedang	195	Kasur/Bulan
PnjlTinggi	422	Kasur/Bulan
Permintaan	300	Kasur/Bulan
Persediaan	421	Kasur/Bulan
Penjualan	251	Kasur/Bulan

Implikasi

[R1] If demand is moderate and sales are moderate and supply is moderate then production is reduced

$$= \text{Min} (0.70; 0.75; 0.29) = 0.29$$

[R2] If demand is moderate and sales are moderate and supply is large then production is reduced

$$= \text{Min} (0.70; 0.75; 0.29) = 0.70$$

[R3] If demand is moderate and sales increase and supply is moderate then production increases

$$= \text{Min} (0.70; 0.25; 0.29) = 0.25$$

[R4] If demand is moderate and sales increase and supply is large then production decreases

$$= \text{Min} (0.70; 0.25; 0.71) = 0.25$$

[R5] If demand is high and sales are moderate and supply is moderate then production increases

$$= \text{Min} (0.30; 0.75; 0.29) = 0.29$$

[R6] If demand is high and sales are moderate and supply is large then production is reduced

$$= \text{Min} (0.30; 0.75; 0.71) = 0.30$$

[R7] If demand is high and sales increase and supply is moderate then production increases

$$= \text{Min} (0.30; 0.25; 0.29) = 0.25$$

[R8] If demand is high and sales increase and supply is large then production increases

$$= \text{Min} (0.30; 0.25; 0.71) = 0.25$$

Compositional Rule

$$\alpha_1 = 0.25 * (412-123) + 123$$

$$\alpha_1 = 195.25$$

$$\alpha_2 = 0.70 * (412-123) + 123$$

$$\alpha_2 = 325.3$$

$$\alpha_3 = 713 - 0.70 * (713-412)$$

$$\alpha_3 = 502.3$$

$$\alpha_4 = 713 - 0.27 * (713-412)$$

$$\alpha_4 = 631.73$$

$$\mu[w]Produksi = \begin{cases} 0,25 & w \leq 92.25 \\ \frac{w-123}{412-123} & 192.25 \leq w \leq 325.3 \\ 0,7; & 325.3 \leq w \leq 412 \\ 0,7; & 412 \leq w \leq 502.3 \\ \frac{713-z}{713-412} & 502.3 \leq w \leq 631.73 \\ 0,27 & w \leq 631.73 \end{cases}$$

Defuzzifikasi

The following calculations can be performed:

$$W * = \frac{M1+M2+M3}{A1+A2+A3} = \frac{121000,678}{291,346} = 415.32 = 415$$

The calculation above shows that the Mamdani fuzzy method predicts a total production of 415 mattresses for that item.

System Interface Implementation

In general, quantitative research methods are approaches to acquire knowledge or solve problems carefully and systematically, using data collected in the form of a set of data or a set of numbers. Because this research involves the output of statistical and descriptive data, this research adopts quantitative data processing methods as data processing methods.

- Implementasi Of Product Prediction

The implementation of this product prediction displays a page for predicting products from last month's / last year's sales which will be predicted for the next sale.

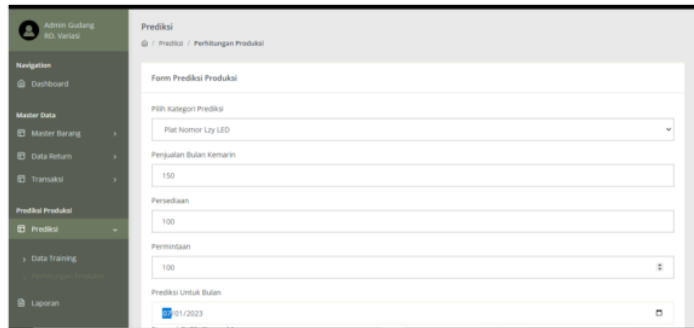


Image 3.3 From Produc

- **Product Prediction Results**

Then the results of the input will be described as shown in the picture, and there is a membership value, the rule composition implications function and finally the Defuzzy result

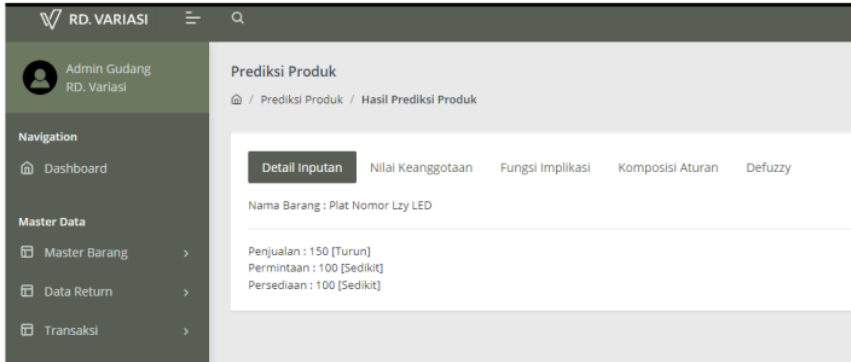


Image 3.4 Prediction Result

- **Defuzzy**

Displays the results of assertion (Defuzzy) and prediction results

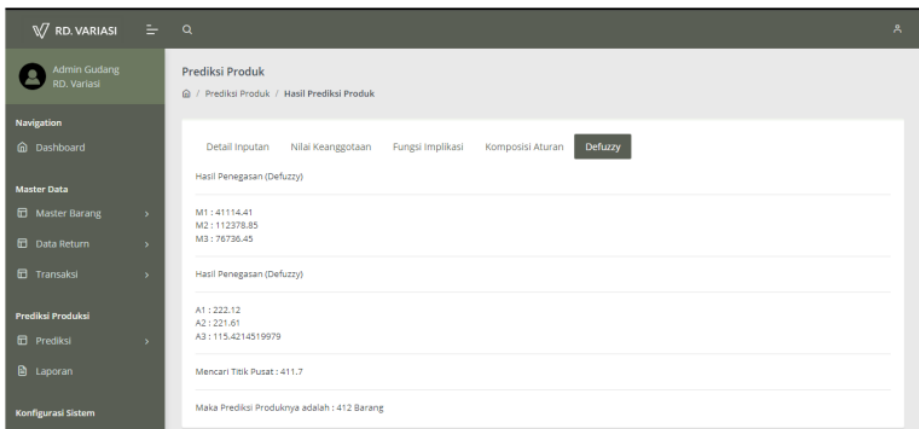


Image 3.5 Defuzzy Prediction Result

- **Comparison Chart**

On the dashboard page a blue and pink graph is displayed, where the blue graph is last year's inventory data and the pink color is the predicted result for the predicted month.

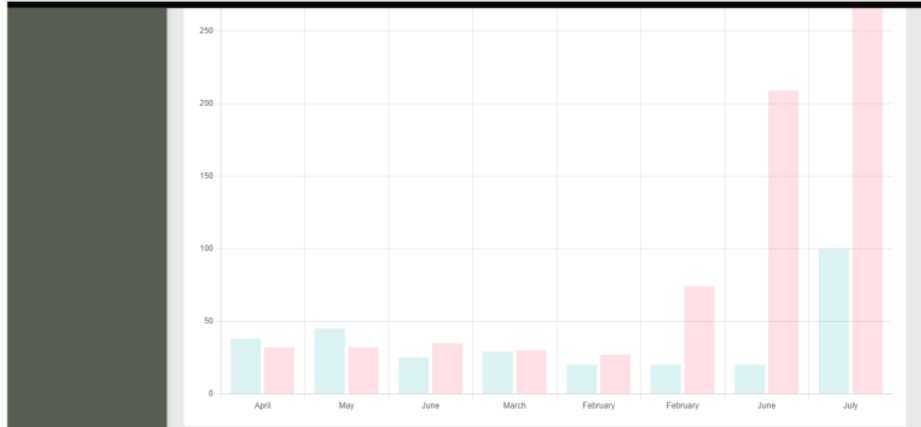


Image 3.6 Comparison Chart

IV. CONCLUSION

11 Berdasarkan hasil penelitian mengenai Penerapan Metode *Fuzzy* Mamdani dalam Rancang Bangun Sistem Informasi Prediksi Produksi Barang Berbasis Web Pada Toko Spare Part RD Variasi dapat disimpulkan bahwa logika *fuzzy* dengan metode mamdani telah efektif diterapkan pada aplikasi ini, dan berdasarkan hasil pengujian aplikasi dapat membantu perusahaan untuk memprediksi produksi barang berdasarkan data variabel seperti permintaan, penjualan, dan persediaan. Hasil pengujian aplikasi ini, diketahui hasil dari data prediksi selama 1 tahun penuh dimana data prediksi tersebut diperoleh dari data dengan variabel persediaan, permintaan, penjualan, dari data bulan sebelumnya untuk di prediksi pada bulan selanjutnya.

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