ABSTRACT

Inventory control modelling is utilized to optimize warehousing cost and the availability of product and raw material while keeping customer satisfaction level. A formulation of fuzzy time series based on raw material planning for fixed-time period safety stock model was proposed to enhance forecasting accuracy in limited data availability. Safety stock levels were computed in monthly fashion to optimizing the most appropriate capacity in each regional warehouse. Forecasting accuracy was based on MAPE indicator. By deploying forecasted data, the calculation of product quantity and capacity level were set to correspond with the target of product box quantity to produce. The result showed that the forecasting of six products in four regions showed the range of MAPE values with minimum at 0.29% and maximum at 1.94% level. The implementation of formula on a real field application had increased the data flow transaction and mobility amount among stakeholders.

Keywords: formulation, fuzzy tim series forecasting, inventory control, modelling, MAPE

INTRODUCTION

The traditional inventory models generally based on parameters as crisp. In practical situations, inventory control involves a range of uncertain situations such as demand and supply on one hand and control on the cost components on the other. The various elements associated with how much to order are normally concerned with inventory costs and inventory lot sizing models. The inventory cost includes the ordering cost, procurement cost, holding cost and shortage cost (Deb et al., 2018). An inventory control system is used to keep inventories in a desired state while continuing to adequately supply customers, and its success depends on maintaining clear records on a periodic or perpetual basis (Efrilianda et al., 2018; Lin, 2020; Singh et al., 2018). There are two types of inventory model based on stock period, single-period inventory model (SPIM), and multi-period inventory model (MPIM). SPIM is designed for products that are highly perishable like newspapers. In another case, MPIM is designed for the stock able products that have dikirim for the time period arrives, whereas FOQ makes an order when the review period arrives, whereas FTP makes an order when the
inventory position drops to the order levels (Rahman et al., 2020; Singh et al., 2018).

Inventory modeling is the representing ideal process on the real-world inventory system in another form that every time developed based on new evidence and understanding, that contains an essential part of a system or phenomenon to be more understandable, definable, calculable, visualization-able, and simulate-able (Azarskov et al., 2017; Hu et al., 2018; Maiti & Maiti, 2006; Nita et al., 2020; Singh, 2019; Singh et al., 2018). The model usually includes essential features needed to understand a system or phenomenon. Forecasting is the determination of value in the future using data from the present and past. The company needs to measure market demand. The most accurate forecasting becomes the basis for the correct decision – making (Deb et al., 2018; Xihao, 2008).

Fuzzy time series method does not depend on the number of data and historical patterns, and needs only little of data. This method is different from Holt’s double exponential smoothing method, which needs more data to increase the accuracy of forecasting (Xihao, 2008). This study focuses on the implementation of the FTP inventory model and forecasting method provided by the herbal product shipping company. This work observed an inventory process problem in a company of herb based products. The problem arose as their current limited and short-term inventory planning must comply with fluctuating demand in the market. There are two tasks in the problem to solve, namely to forecast the target of production rate and the correspondent that dynamic target with the capacity of available warehousing. The outcome of that phenomenon in warehouse management, such as product stock out, and a lot of planned orders resulted in higher cost.

The objectives of this study are to solve this problem explained by formulating fuzzy times series forecasting and to embed this formulation for solution of fixed time inventory model. The rest of this article provides description structure as follows: In the next section provides description of required methods to obtained solution for the objectives, then the next section present the result as solution for the problem. Finally, in the next sequential section provides a discussion of related result and eventually conclusions and recommendation section concludes in the last section.

METHODOLOGY

Inventory Model Framework

In order to fulfill the objective pre-described in the introduction, this study is divided into two major activities, which comply with the research objective explained in the previous section. First activity is data collection, where is derived from repository of historical herbs company. The second activity is quantitative formulation, which uses historical data and provides example of how solution find.

Fuzzy Time Series Forecasting

The first step of the fuzzy time series forecasting method was pre-fuzzification that was determining the sub-universe of discourse by averaged based length. The determination of average based length was done by calculating the I variable (interval) and continued by calculating B variable (interval base). Determination of I by calculation of the average amount of lag absolute between products demand Dk+1 and Dk (k = 1,2,..,12) and divided it by two (Xihao, 2008). In order to illustrate the above process, the formulation is as follows:

\[ \text{Lag Absolute } D_{ij} = \sum_{k=1}^{n} |D_{(k+1)ij} - D_{kij}| \]  

(1)

\[ I = \frac{\text{Lag Absolute } D_{ij}}{2(n-1)} \]  

(2)

From equations 1 and 2, then obtained an interval formulation is as follows:

\[ I = \frac{\sum_{k=1}^{n} |D_{(k+1)ij} - D_{kij}|}{2(n-1)} \]  

(3)

Where:

- \( D_{ij} \) = Amount of product demand in \( i \) – location 
  \( (i = 1,2,3,4) \)
- \( D_{ij} \) = Amount of \( j \) – type product demand in \( i \) – location 
  \( (j = 1,2,..,6) \)
- \( D_{jk} \) = Amount of \( j \) – product demand in \( i \) – location 
  at \( k \) period \( (k = 1,2,..,11) \)
- \( I \) = Interval
- \( n \) = Number of demand data

Interval is rounded to selected basic number based on range. Table 1 is shown interval basic with each range interval.

<table>
<thead>
<tr>
<th>Range</th>
<th>Basic</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1-1</td>
<td>0.1</td>
</tr>
<tr>
<td>1.1-10</td>
<td>1</td>
</tr>
<tr>
<td>11-100</td>
<td>10</td>
</tr>
<tr>
<td>101-1000</td>
<td>100</td>
</tr>
<tr>
<td>1001-10000</td>
<td>1000</td>
</tr>
</tbody>
</table>

When the result of the calculation interval is in one of range, for example if the value 7.4 is in the range of 1.1-10, then the new interval that is used by the base interval (B) is 7. If the value 225.7 is in the range of 101-1000, then the new interval that is used by the base interval (B) is 200. If the value 85.7 is in
the range of 11-100, then the new interval that is used by the base interval (B) is 90.

As B value obtained, the next step is to determine the universe of discourse. Universe of discourse is determined based on historical data and divided into several classes interval (m). Then each class transformed the linguistic value to represent a fuzzy set. Here is an overview of the universe of discourse and some of its parts (sub-universe of discourse):

\[ U = \{ u_1, u_2, \ldots, u_n \} \]

\[ y = \frac{(b-a)}{B} \]

Where,

- \( m = 1,2, \ldots, y \)
- \( U = \text{Universe of discourse} \)
- \( u_m = \text{sub - interval m from universe of discourse} \)

When \( O = (a,b) \), then obtained \( u_1 \) until \( u_m \) by algorithm below:

\[ u_m = \left[ \left( a + (m-1).B \right), \left( a + m.B \right) \right] \]

Where,

- \( O = \text{interval from minimum data to maximum data} \)
- \( l = \text{Length of (maximum data – minimum data)} \)
- \( B = \text{Base interval} \)

The next step is to calculate the frequency of occurrence data from each interval were divided then sort the interval from high to low frequencies. Interval which has a frequency of occurrence of the highest data divided into four sub-intervals, where each of them equals the last interval has the highest frequency. This data-2 is divided into three sub-intervals which are equal in number. Then the interval that having a frequency data is the 3rd highest divided into two sub-intervals equally large and having a frequency interval data is the 4th highest allowed to correspond with the time interval and the interval that does not have the number of times data is erased from disuse later (Maiti & Maiti, 2006). The proposed algorithmic steps for describing the formula is as follows:

\[ u_{m,s} = \begin{cases} 
0 & \text{f = 0} \\
\frac{B}{f} & \text{f = 1} \\
\text{sub - interval s (based on frequency) from sub - interval } u_m \\
\text{f = frequencies data demand on universe of discourse} \\
\end{cases} \]

After determining the \( u_{m,s} \) (universe of discourse based on frequency), the next process was fuzzification all \( u_{m,s} \). If A is a fuzzy set, then it is a numbers fuzzy linguistic variables determined in accordance with the state of the universe, which is the number of intervals obtained from the first step and then these fuzzy numbers are defined according to the following model (Maiti dan Maiti, 2006)

\[ A_c = \left\{ \begin{array}{ll}
1/ u_1 + 0.5 / u_2, & c = 1 \\
0.5 / u_{k-1} + 1/ u_k + 0.5 / u_{k+1}, & 2 \leq c \leq n - 1 \\
0.5/ u_{n-1} + 1/ u_n, & c = n.
\end{array} \right. \]

\[ c = 1 \]

\[ c = 2 \]

Where,

\[ X / U_k = x \text{ is the degree of } u_k \text{'s interval membership} \]

\[ A_c = \text{fuzzy set} \]

When \( c = 1 \), it will be obtained fuzzy set with the least number of demand. If the \( k \) value continues to increase, fuzzy sets will also move from smallest fuzzy set to largest.

Fuzzy logical relationship (FLR) derived from the study of (Xihao, S., 2008), the first order FLR. If demand in the period \( k \) is \( D_{ik} \) which is a member of fuzzy sets \( A_{c-1} \) and the demand in the period \( k+1 \) which is a member of fuzzy sets of \( A_c \), then \( A_{c-1} \) is the current statue and \( A_c \) is next statue. The formula of first order fuzzy logical relationship is \( A_{c-1} \rightarrow A_c \)

Defuzzification process determine the result of the forecast (\( F_{ijk} \)). Defuzzification process differs each demand periods, because it depends on number of data from previous period. Based on (Deb et al., 2018; Efrilianda et al., 2018), de-fuzzification process has some rules based on demand period, there are:

1. If \( k=1 \), \( F_{ij} \) does not have the results because it contains no next statue fuzzy set.
2. If \( k=2 \), \( F_{ij} \) has a middle value results (50%) from next statue fuzzy set.
3. If \( k=3 \), required variable \( P \) dan \( Q \) variable, then the calculation becomes:

\[ P = \frac{1}{2} \times |D_{1,2} - D_{1,3}| \]

\[ Q = \frac{1}{2} \times x u_k \]

\( F_{ij} \) has a middle value results from next statue fuzzy set when \( P=Q \). \( F_{ij} \) have the result 75% of next statue fuzzy set when \( P>Q \). \( F_{ij} \) have the result 25% of next statue fuzzy set when \( P<Q \).

4. If \( k = 3,4, \ldots, 12 \) require \( W, X, Y, Z \) variable, then the calculation becomes:

\[ W = (|D_{(k-3)} - D_{(k-2)}| + |D_{(k-2)} - D_{(k-1)}| + |D_{(k-1)} - D_{(k)}|) \times 2 \]

\[ X = D_{(k-3)} - (|D_{(k-3)} - D_{(k-2)}| - |D_{(k-2)} - D_{(k-1)}| - |D_{(k-1)} - D_{(k)}|) \times 2 \]

\[ Y = (|D_{(k+1)} - D_{(k+2)}| - |D_{(k+2)} - D_{(k+3)}|) / 2 \]

\[ Z = D_{(k+1)} - (|D_{(k+1)} - D_{(k+2)}| + |D_{(k+2)} - D_{(k+3)}|) / 2 \]

\( F_{ij} \) has a middle value results from next statue fuzzy set when \( W \not\in X \cap Y \cap Z \cap \emptyset \). \( F_{ij} \) have the
result 75% of next statue fuzzy set when \( W \times X \in A_c \). \( F_{jk} \) have the result 25% of next statue fuzzy set when \( Y \cup Z \in A_c \).

5. If \( k=13 \), the next statue fuzzy set is unknown, so the forecast result by calculate the middle value of the current state.

**Forecasting Accuracy**

The predictive power is the most important satisfied requirement factors to determine the prediction accuracy. The accuracy of the forecast based on the historical errors of forecasts. The accuracy level of forecasting is higher if the error is getting smaller. Based on (Deb et al., 2018; Manafzadeh and Tan, 2020), the commonly used methods to summarize the historical error is MAPE.

\[
MAPE = \frac{\sum_{i=1}^{n} D_{ijk} \cdot F_{ijk} \times 100}{n} \quad \text{………………. (9)}
\]

**Order Quantity with Safety Stock**

FTP is an inventory control method where orders are periodically computed, but the order quantity is different every time, and is also called Fixed Period Deficit Ordering System. Safety stock is an additional quantity of an item held in inventory in order to reduce the risk that the item will be out of stock.

\[
SS = z \cdot \sigma_{T+L,j} \quad \text{…………………….. (10)}
\]

\[
\sigma_{T+L,j} = \sqrt{\frac{F_{ijk}}{\sum_{i=1}^{n} \sigma_{d,i}^2}} \quad \text{…………………….. (11)}
\]

Because each day is independent and assumption \( d \) is constant, based on Jacobs (2015), formulation 10 and 11 will be:

\[
\sigma_{T+L,j} = z \cdot \sqrt{(T + L_j) \left( \sigma_{ij}^2 \right)} \quad \text{………………. (12)}
\]

Where,

\( SS \) = Safety Stock

\( z \) = Normal distribution of service level

(assumption 95% \( \rightarrow z = 1.64 \))

\( \sigma_{T+L,j} \) = Standard deviation of demand over the review and lead time

\( \sigma_{(T+L)_j} \) = for j-type product in -i location

Order quantity is the number of pieces ordered to replenish the inventory. Inventory is computed only at the specified time for review.

\[
q_{ij} = F_{ij3}(T + L_j) + SS + (-OHI) \quad \text{………………. (13)}
\]

From equations 11 and 12, then obtained an optimal quantity order is as follows:

\[
q_{ij} = F_{ij3}(T + L_j) + z \sqrt{(T + L_j)(\sigma_{ij}^2)} + (-OHI) \quad \text{(14)}
\]

Where,

\( q_{ij} \) = optimal quantity order j – product type on – i location

\( F_{jk} \) = forecasting result

\( L_j \) = Lead time (assumption in all WH location: 1 day)

\( T \) = Time review (assumption in all WH location: 30 day)

\( OHI \) = On Hand Item

Assume that review time (T) is 30 day, lead time (Li) is 1 day, service level is 95%.

**RESULT AND DISCUSSION**

With consideration to demand data, calculation example of SKA360g (i=1) product in Bandung regional warehouse (j=1) has a 13 period demand. Demand data from March 2015 until March 2016 consecutive: 1580, 1613, 1693, 1763, 1729, 1586, 1687, 1634, 1763, 1833, 1897, 1972, 1852, can be determined set the universe \( U = [1580, 1972] \). First process for determining universe of discourse interval divider is calculate the interval (l). interval calculation based on the formula 1 and 2 are as follows:

\[
I = (1580-1613) + (1613-1693) + (1693-1763) + (1763-1729) + (1729-1586) + (1586-1687)
\]

\[
+ (1687-1634) + (1634-1763) + (1763-1833) + (1833-1897) + (1897-1972)
\]

\[
+ (1972-1952) / 2 (13-1)
\]

\[
= 36.33
\]

Based on Table 1, 36.33 is the member interval basic that have value 10, so that the newly interval formed, namely base interval (B), is 40. Length of quantity (l) is 1972-1580 = 392 units , so the value of universe of discourse interval divider (y) is:

\[
y = \frac{392}{40} = 9.8 \approx 10
\]

Divide the universe of discourse \( U = [1580, 1980] \) into 10 sub-interval of length equal intervals. Based on formula 4, sub-interval value follows the calculation below:

\[
m=1,2,3,…..,10
\]

\[
u_1 = \left(1580+(1-1.40),(1580+(1.40))\right)
\]

\[
= [1580, 1620]
\]

\[
u_2 = \left(1580+(2-1.40),(1580+(2.40))\right)
\]

\[
= [1620,1660]
\]

\[
u_{10} = \left(1580+(10-1.40),(1580+(10.40))\right)
\]

\[
= [1940, 1980]
\]
Based on formula 3 the calculation above can be shown as bellow:

\[ U = \{ u_1, u_2, u_3, u_4, u_5, u_6, u_7, u_8, u_9, u_{10} \} = \{ [1580,1620), [1620,1660), [1660,1700), [1700,1740), [1740,1780), [1780,1820), [1820,1860), [1860,1900), [1900,1940), [1940,1980] \} \]

After getting the universe of discourse and sub-interval, the demand data is classified to the each sub-interval. The amount of data that included in the sub-interval portion is calculated as the frequency. Table 2 shows the frequency and demand data which belong to sub-intervals.

Sub-interval of the universe of discourse which has the highest frequency is \( u_1 \) with three frequencies so that \( u_1 \) divided into three equal intervals, namely sub of sub-interval or sub-interval based on frequencies, becomes \( u_{1,1}, u_{1,2}, \) and \( u_{1,3} \). Then the sub-interval which has two frequencies are \( u_2, u_4, u_6 \) divided into two equally intervals become \( u_1,1, u_1,2, u_2,1, u_2,2, u_4,1, u_4,2, u_6,1, \) and \( u_6,2 \). Sub-interval which has one frequency doesn’t need to be divided. Then the last, sub-interval which hasn’t be in frequency level is not used. Based on formula 5, the example calculation of sub-interval based on frequency is a newly formed interval data based on frequency:

\[
\begin{align*}
\text{Sub UOD} & \quad \text{Length interval (unit)} & \quad \text{Data part of Sub-interval} & \quad \text{Frequency} \\
\text{u}_1 & \quad [1580,1620) & \quad 1580, 1613, 1586 & \quad 3 \\
\text{u}_2 & \quad [1620,1660) & \quad 1634 & \quad 1 \\
\text{u}_3 & \quad [1660,1700) & \quad 1687, 1693 & \quad 2 \\
\text{u}_4 & \quad [1700,1740) & \quad 1729 & \quad 1 \\
\text{u}_5 & \quad [1740,1780) & \quad 1763,1763 & \quad 2 \\
\text{u}_6 & \quad [1780,1820) & \quad - & \quad 0 \\
\text{u}_7 & \quad [1820,1860) & \quad 1833 & \quad 1 \\
\text{u}_8 & \quad [1860,1900) & \quad 1897 & \quad 1 \\
\text{u}_9 & \quad [1900,1940) & \quad - & \quad 0 \\
\text{u}_{10} & \quad [1940,1980] & \quad 1972,1952 & \quad 2
\end{align*}
\]
By using (Maiti dan Maiti, 2006) fuzzy set model, a fuzzification model was developed. For example, assume that the SKA360gr (i=1) product in Bandung regional warehouse (j=1) we get fuzzy set result which is followed by its interval membership degree. The fuzzification model is obtained as follows:

\[ A_1 = \frac{1}{u_{1,1}} + 0.5/u_{1,2}, \]
\[ A_2 = 0.5/u_{1,1} + 1/u_{1,2} + 0.5/u_{1,3}, \]
\[ A_{13} = \frac{0.5}{u_{10,1}} + 1/u_{10,2}. \]

Fuzzy set is obtained from fuzzification models which have each interval. Then fuzzy set is used to compute fuzzified product demand in each period. After the fuzzification process obtained, FLR is able to determine and de-fuzzification process proceeds. By using observation data, defuzzification for product SKA 360gr (i=1) in the regional warehouse Bandung (j=1) to determine the results of forecasting \( F_{ijk} \) are as follows:

1. In March 2015 (k=1), the forecasting result of \( F_{ij1} \) not have the results because there is no data in the previous month.
2. In April 2015 (k=2), has a degree of membership in the fuzzy set A3, at \( u_{1,3} = [1607,1620) \). Forecasting result of \( F_{ij2} \) is the midpoint of the interval \( u_{1,3} \) that is equal to 1613.
3. In May 2015 (k=3), has a degree of membership in the fuzzy set A6 at \( u_{3,2} = [1680,1700) \). The membership in the fuzzy set A6 at \( u_{3,2} \) that is equal to 1695.

Calculation show that \( P > Q \) so the forecasting result is upward or ground of the interval \( u_{3,2} \) that is equal to 1695.

4. In June 2015 (k=4), has a degree of membership in the fuzzy set A9, at \( u_{5,2} = [1760,1780) \). Forecasting result of \( F_{ij3} \) based on formulation 8 are as follows:

\[ W = \left(\frac{1}{1693-1613} - 1613-1613-1580 + 1693\right) \times 2 = 3480 \]
\[ X = \left(1693-\left(1693-1613\right) - 1613-1613-1580\right) \times 2 = 1599 \]
\[ Y = \left(1693-1613 - 1613-1613-1580 + 1693\right) / 2 = 870 \]
\[ Z = 1693-\left(1693-1613\right) - 1613-1613-1580 / 2 = 1669 \]

Calculation show that \( W \cap X \cap Y \cap Z \cap A9 \), so the forecasting result is middle value or 50% of the interval \( u_{5,2} \) that is equal to 1770.

5. In March 2016 (k=13) because it does not have the next state, then the results of forecasting by using the middle value of the current state that has one degree of membership in the fuzzy set A12 at \( u_{10,1} = [1940,1960) \). So the forecasting result is 1950.

Results SKA 360gr product demand forecasting at regional warehouses are shown in Table 3

**Forecast Accuracy**

The predictive power is the most important factor to determine goodness of prediction results. The accuracy of the forecast based on the historical errors of forecasts. After getting the result of forecasting, the error value after forecasting is estimated based on formulation 9.

<table>
<thead>
<tr>
<th>Month/period</th>
<th>Demand (unit)</th>
<th>Fuzzification</th>
<th>FLR</th>
<th>Forecasting (Unit)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mar-15</td>
<td>1580</td>
<td>A1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Apr-15</td>
<td>1613</td>
<td>A3</td>
<td>A1→A3</td>
<td>1613</td>
</tr>
<tr>
<td>Mei-15</td>
<td>1693</td>
<td>A6</td>
<td>A3→A6</td>
<td>1695</td>
</tr>
<tr>
<td>Jun-15</td>
<td>1763</td>
<td>A9</td>
<td>A6→A9</td>
<td>1770</td>
</tr>
<tr>
<td>Jul-15</td>
<td>1729</td>
<td>A7</td>
<td>A9→A7</td>
<td>1720</td>
</tr>
<tr>
<td>Aug-15</td>
<td>1586</td>
<td>A1</td>
<td>A7→A1</td>
<td>1587</td>
</tr>
<tr>
<td>Sep-15</td>
<td>1687</td>
<td>A6</td>
<td>A1→A6</td>
<td>1690</td>
</tr>
<tr>
<td>Oct-15</td>
<td>1634</td>
<td>A4</td>
<td>A6→A4</td>
<td>1640</td>
</tr>
<tr>
<td>Nov-15</td>
<td>1763</td>
<td>A9</td>
<td>A4→A9</td>
<td>1770</td>
</tr>
<tr>
<td>Des-15</td>
<td>1833</td>
<td>A10</td>
<td>A9→A10</td>
<td>1840</td>
</tr>
<tr>
<td>Jan-16</td>
<td>1897</td>
<td>A11</td>
<td>A10→A11</td>
<td>1880</td>
</tr>
<tr>
<td>Feb-16</td>
<td>1972</td>
<td>A13</td>
<td>A11→A13</td>
<td>1970</td>
</tr>
<tr>
<td>Mar-16</td>
<td>1952</td>
<td>A12</td>
<td>A13→A12</td>
<td>1950</td>
</tr>
<tr>
<td>Apr-16</td>
<td>-</td>
<td>-</td>
<td>A12→n</td>
<td>1950</td>
</tr>
</tbody>
</table>
It is found that the range of MAPE between maximum value at 1.94%, and minimum value at 0.29%.

Order Quantity with Safety Stock

After being known that the results of demand forecasting using fuzzy time series have good MAPE value, then the next step is to determine the number of products shipped in each regional warehouses based on formulation 14. From the previous calculations and assumptions, it is known that the results of forecasting products \( F_{ij13} \) is 1950 unit, then \( T + L_i = 31 \) and \( z \rightarrow 95\% = 1.65 \). The 12 previous demand data, standard deviation \( \sigma_{ij} \) of product demand is 128. Table 4 shows the number of on handed items (OHI) every product in each regional warehouse location.

So the results of the calculations are:

\[
q_{ij} = F_{ij13}(T + L_i) + z \sqrt{(T + L_i)(\sigma_{ij})^2} + (-OHI)
\]

\[
q_{ij} = 1950(31) + 1.65 \sqrt{(31)(128)^2} + (-25)
\]

\[= 2029 \text{ unit}\]

Discussion

FTP is an inventory control system where orders are periodically computed, but the order quantity is different every time, and is also called Fixed Period Deficit Ordering System. These generally require a higher level of safety stock than a fixed-order quantity system. FTP system assumes continual tracking of inventory on hand, with an order immediately placed when the reorder point is reached.

In contrast, the standard FTP models assume that inventory is counted only at the time specified for review. Safety stock is an additional quantity of an item held in inventory in order to reduce the risk that the item will be out of stock. Safety stock acts as a buffer in case the sales of an item are greater than planned and/or the supplier is unable to deliver additional units at the expected time.

Maximum value of MAPE value obtained from forecast results was 1.94%, whereas the minimum value of MAPE was 0.29%. As the consequence of these figures, it is in accuracy-range from the forecasting is from 98% to 99.7%. The accuracy of this forecasting would remain the same regardless the pattern or amount of the data as (Amjad et al., 2018; Maiti, 2020; Xihao, 2008)) explained that Fuzzy Time Series Forecasting is not influenced by those factors. Calculation from the pre-fuzzification until the determination of the order quantity based safety stock is not only applied to the product SKA360gr in regional warehouses Bandung, but also applied to the product SKK250gr, SKK330gr, HBS KA 100, HBS KA 120, HBS KA 210 in all regional warehouses, namely Bandung, Tangerang, Cilegon, and Sukabumi areas.

Advantages and Limitation

The advantage of this research is to the ability to determine the number of order quantity to ship in each regional warehouses. Moreover, the fuzzy time series forecasting approach potentially applicable for any inventory model. The limitation of this formulation lays on its fixed time period inventory type. It requires for significant adjustment for other types of inventory model.

Table 4. Number of on handed item every product in each regional warehouse

<table>
<thead>
<tr>
<th>Regional WH Location</th>
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CONCLUSION AND RECOMMENDATION

Conclusion
This work proposed a fuzzy time series to forecasting the product demand in a herbal product distribution company. Inventory problems in each regional warehouse, where a fixed time period inventory model was applied. The accuracy is ranging from 98% to 99.7%. The accuracy of this forecasting tend to remain the same regardless of the pattern or amount of the data. With respect to similar inventory model, this approach is applicable to any type of company.

Recommendation
Based on limitation previously explained, it recommends to implement the formulation with several adjustment on current data processing for a broader stakeholder inventory model.

REFERENCE