

PREDICTION FOR TOTAL NUMBER OF LAB PARTICIPANTS BY FUZZY TIME SERIES METHOD (CASE STUDY: INFORMATION ENGINEERING OF BHAYANGKARA SURABAYA UNIVERSITY)

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ABSTRACT

Forecasting is a way to estimate a future value with using past data. One method of forecasting is the fuzzy method time series. The purpose of this study is to predict the number of students practitioners follow Department of Informatics University Bhayangkara Surabaya by using fuzzy method time series. The created app can be used to predict the next 1 year. If the actual data in the year predicted inputted, the application can predict the next year again. The prediction error rate is calculated using Mean Absolute Percentage Error (MAPE). From the test results in predicting the number of students followers 7 courses Practicum Informatics Engineering Bhayangkara University of Surabaya in 2010-2012 using the method proposed in this thesis for practicum PTI obtained MAPE value of 20.50%, Practical ANP obtained MAPE value of 0.50%, Network Computer practicum obtained MAPE value at 8.50%, practicum Database obtained MAPE value of 0.50%, Managemen Network Computer practicum obtained MAPE value of 14.50%, practicum PKG obtained MAPE value of 0.84% and practicum PBO obtained MAPE value of 0.21%. Based on the results of testing the data it can be concluded that the fuzzy time series method when used on more data many, it will get the accuracy of better and precise forecasting values.

Keywords: Forecasting, Fuzzy Time series, Mean Absolute Percentage Error (MAPE).

1. INTRODUCTION

1.1. Background

In human life always faced with several options, where with the forecasting can help in predicting activity on life in the future. Forecasting is a process which aims to predict in between some alternative actions will concluded so that can be expected in helps to determine the outcome. Forecasting for decision making as well experienced by the Faculty of Informatics Engineering Bhayangkara University in determining participants of practicum followers. Lack of information on the number of students who follow the practicum and the student already complete the requirements of the lab, so difficult in determining many students who follow the lab. For avoid it, then it is needed a system that can help the part academic in solving deep problems predict and determine follower followers practice. The student forecasting process following the lab can be predicted with the availability of more than one option possibilities. Then used forecasting with the method Fuzzy Time Series that can help in decision making on the best and worst possible in order to obtain good results meet certain criteria. Forecasting with the Fuzzy Time Series method is based off data of applicants of the practicum obtained from Lecturer Chairman of Engineering Praktikum Department Informatics of Bhayangkara University with proof of payment from bank and KRS data college student. With that method expected results can help determine the participants who follow practicum Informatics Engineering Department.

1.2. Purpose

This research aims to apply the Fuzzy Time Series method to helping to predict the number of students participants of practicum Engineering followers Informatics of Bhayangkara University Surabaya, so it can be determined on a regular basis easy to see the level of accuracy forecasting.

2. METHODOLOGY

2.1. Literature review

There are several previous studies which uses the Fuzzy Time method Series, such as Average-Based Fuzzy Time Series for exchange rate forecasting foreign exchange (USDIDR Exchange Rate Case Study and EUR-USD) [11], forecasting the percentage change of data Composite Stock Price Index (CSPI) With Fuzzy Time Series [10], forecasting the sales method of Fuzzy Time Series Ruey Chyn Tsaur [12], Application of Fuzzy Time Series By Elliott Wave Principle For Stock Price Prediction [14], Forecasting Number of Candidates Student Stmik Duta Bangsa Using Time Invariant Fuzzy Time Series Method [13], Forecasting System Movement of Capital Market Index With The Fuzzy Time Series Method.

2.2. System planning

2.2.1. DFD Level 0

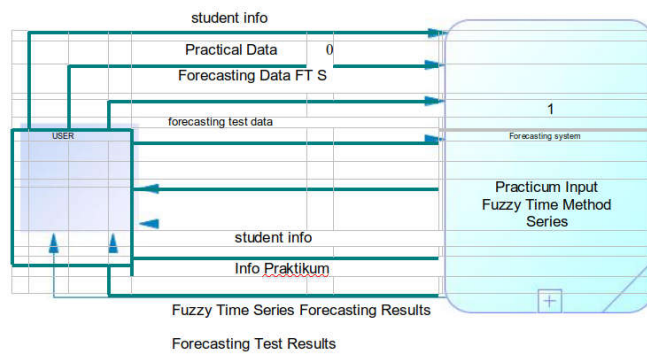


Figure 1. DFD Level 0

The level 0 chart will be decomposed into several sub-process level diagrams next called the level 1 diagram. There are several sub processes in the diagram next flow among others Logging, Manage Master Data, Calculation of Forecasting Method FTS and FTS Forecasting Testing. There is some data store of them is user, students, practicum, FTS forecasting, and FTS testing. The diagram in figure 1 shows process level diagram 1.

2.2.2. DFD Level 1

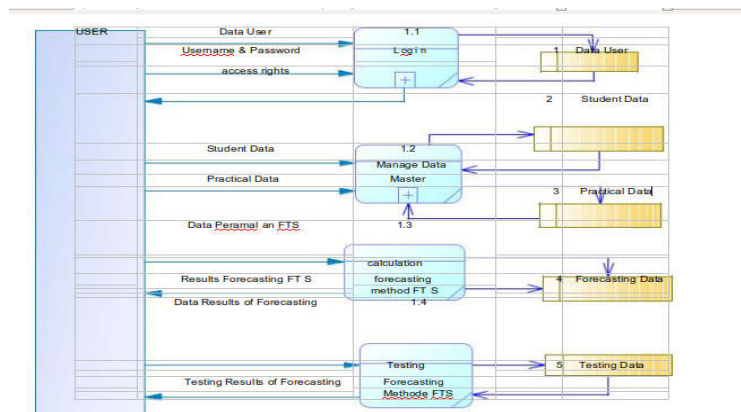


Figure 2. DFD Level 1

Any process found on the level 1 diagram will be decomposed again into sub-chapters of level diagram process next. Login Sub at level 2 will be decomposed into 3 processes and 1 data restore. 3 process consists of insert, update user data and Access Rights checking. While the data restorenya is Data user. Figure 2 shows sub login process.

2.2.3. DFD Level 2

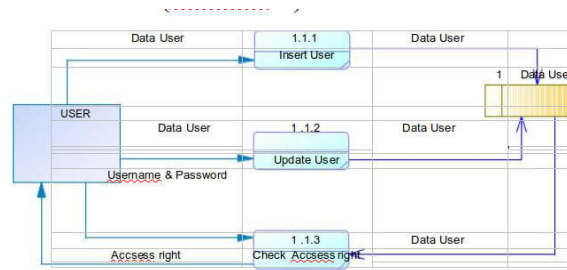


Figure 3. DFD Level 2 Login

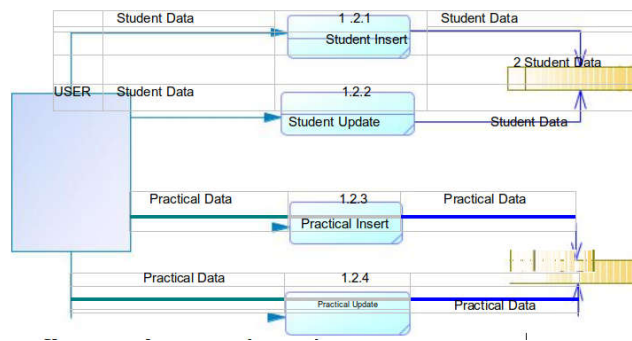


Figure 4. DFD level 2 manage master data

DFD level 2 is a depiction from each process that exist on level 1 DFD, is DFD level 2 login process (Figure 3), and DFD level 2 manage master data (Figure 4).

2.3. Fuzzy Time Series Method

Steps in forecasting participants using practicum followers method of Fuzzy Time Series in this research are as follows (Hsu et al. 2010):

1. The set of the universe.

The universal set $U = [D_{min} , D_{max}]$ determined according to historical data exist, and divide it into an odd number of sub-intervals with equal width intervals.

2. Fuzzification Process

A_1 , A_2 , \dots , A_k is a fuzzy sets that are the linguistic variable is determined according to the state of the universe, at where k is the number of intervals obtained from the first step then define the set of sets The fuzzy according the following models (Song and Chissom):

$$A_k = \begin{cases} 1/u_1 + 0.5/u_2 , & k = 1 \\ 0.5/u_{k-1} + 1/u_k + 0.5/u_{k+1} , & 2 \leq k \leq n - 1 \\ 0.5/u_{n-1} + 1/u_n , & k = n \end{cases}$$

is a degree deep u_k interval membership fuzzy set A_k at $k = 1$, a fuzzy set is obtained (fuzzy set of student numbers the fewest). At $k = n$, obtained (fuzzy set of numbers student of the most). The greater the value of k , the fuzzy set the number of students will move from the least become the set fuzzy number of students the most many.

3. Second-order fuzzy logical relationship

If the result of fuzzification number of students in the year $i-2$ is, amount student in the year $i-1$ is then the number of students in year I is, where, as a side left relationship is referred to as current state and A_k as the right side relationship referred to as next state. Fuzzy logical relationship group formed by dividing fuzzy logical relationship that has been obtained into sections based on the left side of the fuzzy logical relationship (current state).

4. Defuzzification process

The defuzzification process changes a fuzzy quantities become strict quantities. The output in this process is a forecasting value determined using the following rules:

- (1) If in the group is obtained exactly one next state, as fuzzy logical relationship follows:

$$A_i, A_j \rightarrow A_k$$

where is the maximum degree of degree of membership from A_K at intervals U_K , and midpost (middle value) of U_K is A_K , then the forecasting value for the group in question is M_k .

- (2) If in the group get more from one next state, as fuzzy logical relationship follows:

$A_I, A_J \rightarrow A_{k1}, A_{k2}... A_{kn}$ where the maximum value of degree membership from at $A_{k1}, A_{k2}... A_{kn}$ intervals $U_{k1}, U_{k2}... U_{kn}$ and midpost (middle value) of $U_{k1}, U_{k2}... U_{kn}$ is $m_{k1}, m_{k2}... m_{kn}$ then forecasting value for the group is $(m_{k1} + m_{k2}... + U_{kn})/n$

- (3) If the group is not found next state, as fuzzy logical

relationship follows: $A_I, A_J \rightarrow \#$ where # denotes unknown value and maximum value of degree of membership from A_I and A_J available at intervals u_i and u_j and and midpost (middle values) of u_i and u_i is M_I and M_J then the forecasting value for that group is $M_J + ((M_I M_J) / 2)$.

5. Forecast rules

This stage consists of two parts, namely matching part (current state of fuzzy logical relationship group) and forecasted value. Determination of forecast value is determined by matching current state fuzzy logical relationship year i with matching part. If current state with rules which has formed a match, then forecast value in the same year as forecast value of the matching part concerned.

2.4. System View



Figure 5. Views of Results and Value Pages UoD Range

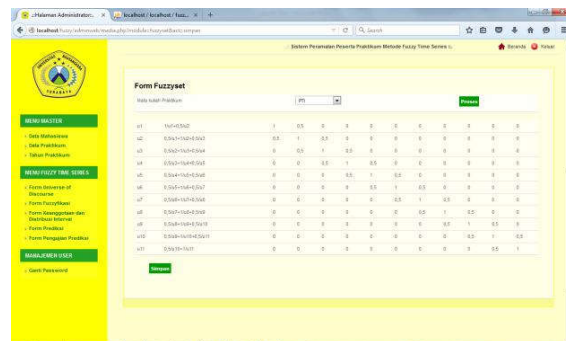


Figure 6. Results of Fuzzyfication Results

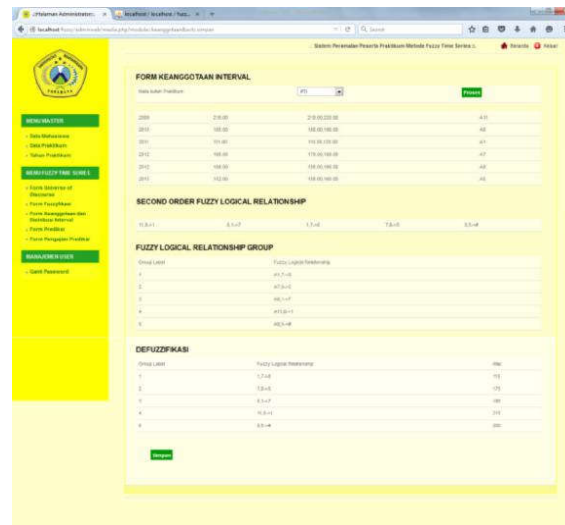


Figure 7. Result Pages Membership and Interval Distribution

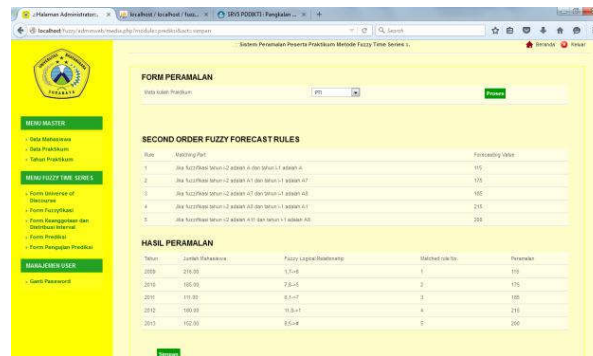


Figure 8. Forecasting Page Views

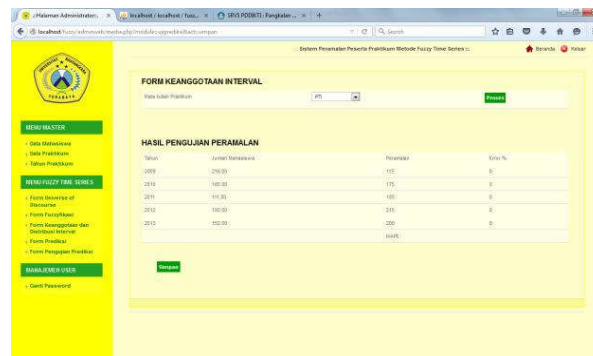


Figure 9. Pageviews Result Testing Data Forecasting

3. RESULT AND DISCUSSION

3.1. Experiment Results

The experiment was conducted on participant data practicum majoring in Informatics Engineering Bhayangkara University began year 2010 to 2012 with 7 courses practicum can be seen in table 4.1 and experiments are also performed on the Amount data Student who practicum in Laboratory Livestock Reproduction Faculty of Animal Husbandry Universitas Brawijaya year 2010-2014 as comparison data can be seen on table 6.37. Experiment done with using the Fuzzy Time Series and methods using MAPE (Mean Absolute Percentage Error) to analyze precision

forecasting method. Method Appropriate forecasting is a method resulting in a minimum MAPE. Based on table 4.1 of 7 courses practice could do process counting follower of follower followers practicum as follows:

1. Data of PTI practicum participants

- Universe of Discourse with value $D_{min} = 10$ and the value $D_{max} = 218$, then the universal set $U = [10, 220]$ and divide it into 21 sub-interval with interval length which is just as great.

- $u1 = [10, 20]$ $u12 = [120, 130]$
 $u2 = [20, 30]$ $u13 = [130, 140]$
 $u3 = [30, 40]$ $u14 = [140, 150]$
 $u4 = [40, 50]$ $u15 = [150, 160]$
 $u5 = [50, 60]$ $u16 = [160, 170]$
 $u6 = [60, 70]$ $u17 = [170, 180]$
 $u7 = [70, 80]$ $u18 = [180, 190]$
 $u8 = [80, 90]$ $u19 = [190, 200]$
 $u9 = [90, 100]$ $u20 = [200, 210]$
 $u10 = [100, 110]$ $u21 = [210, 220]$
 $u11 = [110, 120]$

- Fuzzification process

Retrieved:

- $A1 = 1/u1 + 0.5/u2$
 $A2 = 0.5/u1 + 1/u2 + 0.5/u3$
 $A3 = 0.5/u2 + 1/u3 + 0.5/u4$
 $A4 = 0.5/u3 + 1/u4 + 0.5/u5$
 $A5 = 0.5/u4 + 1/u5 + 0.5/u6$
 $A6 = 0.5/u5 + 1/u6 + 0.5/u7$
 $A7 = 0.5/u6 + 1/u7 + 0.5/u8$
 $A8 = 0.5/u7 + 1/u8 + 0.5/u9$
 $A9 = 0.5/u8 + 1/u9 + 0.5/u10$
 $A10 = 0.5/u9 + 1/u10 + 0.5/u11$
 $A11 = 0.5/u10 + 1/u11 + 0.5/u12$
 $A12 = 0.5/u11 + 1/u12 + 0.5/u13$
 $A13 = 0.5/u12 + 1/u13 + 0.5/u14$
 $A14 = 0.5/u13 + 1/u14 + 0.5/u15$
 $A15 = 0.5/u14 + 1/u15 + 0.5/u16$
 $A16 = 0.5/u15 + 1/u16 + 0.5/u17$
 $A17 = 0.5/u16 + 1/u17 + 0.5/u18$
 $A18 = 0.5/u17 + 1/u18 + 0.5/u19$
 $A19 = 0.5/u18 + 1/u19 + 0.5/u20$
 $A20 = 0.5/u19 + 1/u20 + 0.5/u21$
 $A21 = 0.5/u20 + 1/u21$

Overall, the results of the process fuzzification of the data can be seen in Table 3.1.

Year	College student	Amount Fuzzification
2010	218	A21
2011	128	A12
2012	10	A1

Table 3.1 Practical Fuzzification Data PTI

- Second-order fuzzy logical relationship
 Based on fuzzification results on the second step, can be determined second order fuzzy logical relationship that can be seen on table 3.2 and table 3.3

A21,A12→A1	A12,A1->#
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Table 3.2 Second-order fuzzy logical relationship PTI Practicum

Group Label	Fuzzy Logical Relationship Group
1	A21,A12->A1
2	A12,A1->#

Table 3.3 Second-order fuzzy logical relationship group PTI Practicum

- Defuzzification process
 Group 1 calculation, from Table 3.3 as follows :
 A21, A12 → A1 where the membership value is maximumvfor the fuzzy set A1 falls on interval u21 = [210, 220], and value the middle of the interval of u21 is 215 then forecasting value for group 1 is 215.
 Group 2 calculation, from Table 3.3 as follows :
 A12, A1 → #
 where the maximum value of degree membership of A12 and A1 falls at intervals u12 = [120, 130] and u1 = [10, 20] and midpost (middle value) of u12 and u1 are 125 and 15, then forecasting value for the group in question is $15 + ((15 - 125) / 2)$ ie -40.
- Forecast rules
 Based on defuzzification results on the fourth step, can be determined some rules that can be seen on table 3.4 and has been obtained in the table 3.5.

Rule	Matching Part Forecasting	Value
1	If fuzzification of year i-2 is A12 and year i-1 are A1	215

Table 3.4 Second-order fuzzy forecast rules Practicum PTI

Year	number of students	Fuzzy Logical Relationship	Matched Rule No.	forecasting
2010	218	-	-	-
2011	128	-	-	-
2012	10	A12, A1 → #	1	215
2013	-	A1, A2 → #	2	-40

Table 3.5 Application of fuzzy time method series PTI Practicum

- Testing data

Year	number of students	forecasting	Error%
2010	218		
2011	128		
2012	10	-215	20,50
2013	-	-40	0
TOTAL MAPE			20,50

Table 3.6 Testing MAPE data PTI lab work

Then tested the data for analyze accuracy method that used by generating a MAPE minimum. From Table 3.6 it can be seen that in forecasting the number of student followers practicum PTI with fuzzy time method series obtained a total value of MAPE of 20.50%

2. Data of ANP practicum participants

By whole, results process forecasting the data can be seen on table 3.7

Year	number of students	Fuzzy Logical Relationship	Matched Rule Nol	Forecasting
2010	10	-	-	-
2011	164	-	-	-
2012	10	A16, A1 → #	2	15
2013	-	A17, A18 → #	-	-60

Table 3.7 Application of fuzzy time method series ANP Practicum

- Testing data

Year	number of students	Forecasting	Error %
2010	10	-	-
2011	164	-	-
2012	10	15	0,50
2013	-	-60	0
TOTAL MAPE	0,50		

Table 3.8 MAPE Testing of practicum data ANP

Then tested the data for analyze the accuracy of that method used by generating MAPE the minimum. From Table 3.8 it can be seen that in forecasting amount student of practicum followers ANP with the fuzzy time series method got MAPE total value of 0.50%.

3. Data of practicum participants Jarkom

By whole, results process forecasting the data can be seen on table 3.9.

Year	number of students	Fuzzy Logical Relationship	Matched Rule Nol	Forecasting
2010	93	-	-	-
2011	90	-	-	-
2012	10	A8, A1 → #	2	95
2013	-	A10, A11 → #	-	-20

Table 3.9 Application of fuzzy time method series Practicum Jarkom

- Testing data

Year	number of students	Forecasting	Error%
2010	93	-	-
2011	90	-	-
2012	10	95	8,50
2013	-	-20	0
TOTAL MAPE	8,50		

Table 3.10 MAPE Testing of practicum data Jarkom

Then tested the data for analyze accuracy method that used by generating a MAPE minimum. From Table 3.10 can be seen that in forecasting the number of students followers of Jarkom practice by method fuzzy time series got the total value of MAPE by 8.50%.

4. Data of participants of Database practicum By whole, results process such data forecasting can be seen in Table 3.11.

Year	Number of students	Fuzzy logical Relationship	Matched Rule No.	Forecastig
2010	10	-	-	-
2011	98	-	-	-
2012	10	A9, A1 → #	2	15
2013	-	A10, A11 → #	-	-25

Table 3.11 Application of fuzzy time method series Database Practicum

- Testing Data

Year	Number of students	Forecasting	Error %
2010	10	-	-
2011	98	-	-
2012	10	15	0,50
2013	-	-25	0
TOTAL MAPE	0,50		

Table 3.12 MAPE Testing of practicum data Database

Then tested the data for analyze the accuracy of that method used by generating MAPE the minimum. From Table 3.12 it can be seen that in forecasting amount student of Database practicum followers with the fuzzy time series method obtained a total value of MAPE of 0.50%

5. Data of Manjarkom practicum participants By whole, results process forecasting the data can be seen on table 3.13.

Year	Number of students	Fuzzy Logical Relationship	Matched Rule No.	FORECASTING
2010	155	-	-	-
2011	85	-	-	-
2012	10	A8 A1 → #	2	155
2013	-	A16, A17 → #	-	-20

Table 3.13 Application of the fuzzy time series method Manjarkom Practicum

- Testing Data

Year	Number of students	Forecasting	Error%
2010	155	-	-
2011	85	-	-
2012	10	155	14,50
2013	-	-20	0
TOTAL MAPE	14,50		

Table 3.14 MAPE Testing of practicum data Manjarkom

Then tested the data for analyze accuracy method that used by generating a MAPE minimum. From Table 3.14 it can be seen that in forecasting the number of student followers Manjarkom practice with fuzzy method time series obtained the total value of MAPE of 14.50%

6. Data of PKG practicum participants By whole, results process forecasting the data can be seen on table 3.15.

Year	Number of students	Fuzzy Logical Relationship	Matched Rule No.	Forecasting
2010	10	-	-	-
2011	90	-	-	-
2012	93	A1, A9 → #	2	520
2013	-	A10, A11 → #	-	-100

Table 3.15 Application of fuzzy time method series PKG Practicum

- Data Testing

Year	Number of students	Forecasting	Error%
2010	10	-	-
2011	10	-	-
2012	93	15	0,84
2013	-	135	0
TOTAL MAPE	0,84		

Table 3.16 Testing MAPE data practicum PKG

Then tested the data for analyze accuracy method that used by generating a MAPE minimum. From Table 3.16 it can be seen that in forecasting the number of student followers practicum PKG with fuzzy time method series obtained a total value of MAPE of 0.84%.

7. Data of PBO practicum participants

By whole, results process forecasting the data can be seen on table 3.17.

Year	Number of students	Fuzzy Logical Relationship	Matched Rule No.	forecasting
2010	15	-	-	-
2011	51	-	-	-
2012	19	A5, A1 → #	2	15
2013	-	A6, A7 → #	-	-5

Table 3.17 Application of the fuzzy time series method PBO Practicum

- Data Testing

year	Number of students	Forecasting	Error%
2010	15		
2011	51		
2012	19	15	0,21
2013	-	-5	0
TOTAL MAPE	0,21		

Table 3.18 MAPE Testing of practicum data PBO

Then tested the data to analyze the accuracy of that method used by generating a MAPE minimum. From Table 3.18 it can be seen that in forecasting the number of students follower of PBO with fuzzy method time series obtained the total value of MAPE of 0.21%. Experiment as a comparison analysis performed on the Number of Student data lab in the Reproduction Laboratory Livestock Faculty of Animal Husbandry University Brawijaya year 2010-2014, with data as follows :

YEAR	Practical Courses	NUMBER OF STUDENTS PRACTICUM
2010	Biotechnology	18
	Animal Reproduction Science	14
2011	Biotechnology	54
	Animal Reproduction Science	232
2012	Biotechnology	69
	Animal Reproduction Science	356
2013	Biotechnology	165
	Animal Reproduction Science	792
2014	Biotechnology	161
	Animal Reproduction Science	537

Table 3.19 Data Number of Students in practicum Reproduction Laboratory

Results forecasting of 2 courses practicum data Number of Students who practicum at Livestock Reproduction Laboratory Faculty Universitas Brawijaya Farming in 2010 - 2014, can be seen in table 3.20 and table 3.21. Then the test results can be seen in Table 3.46 and Table 3.47.

YEAR	Number of students	Fuzzy logical Relationship	Matched Rule No.	forecasting
2010	18	-	-	-
2011	54	-	-	-
2012	69	A1, A5 → A6	1	15
2013	165	A5, A6 → A16	2	55
2014	161	A6, A16 → A16	3	65
2015	-	A16, A16 → #	4	165

Table 3.20 Application of the fuzzy time series method Number of students of Biotechnology practicum

- data testing

year	Number of students	Forecasting	Error%
2010	18	-	-
2011	54	-	-
2012	69	15	0,78
2013	165	55	0,67
2014	161	65	0,60
2015	-	165	-
TOTAL MAPE			1,65

Table 3.21 Testing MAPE data Amount Student of Biotechnology practicum

Year	Number of students	Fuzzy logical relationship	Matched Rule No.	Forecasting
2010	14	-	-	-
2011	232	-	-	-
2012	356	A1, A5 → A6	1	15
2013	792	A5, A6 → A16	2	235
2014	537	A6, A16 → A16	3	355
2015	-	A16, A16 → #	4	405

Table 3.22 Application of the fuzzy time series method Number Amount Student of Livestock Reproduction Laboratory

- data testing

year	Number of students	Forecasting	Error%
2010	18	-	-
2011	54	-	-
2012	69	15	0,96
2013	165	235	0,70
2014	161	355	0,34
2015	-	405	-
TOTAL MAPE	1,77		

Table 3.23 Testing MAPE data Amount Student of Biotechnology practicum

3.2 Analysis of Results

Based on data forecasting results of the eye college practicum, it appears that if there is empty data (zero) and too few periods, then the amount of data entered into forecasting process with fuzzy time method series shows less results maximum. As for forecasting on the comparison data is the number of students the practicum in the Reproduction Laboratory Livestock Faculty of Animal Husbandry University Brawijaya can still show results better forecasting than data participants of Informatics Engineering Bhayangkara University Surabaya. On testing the measurement process data forecasting error rate followers practice majors Technique Informatics University Bhayangkara Surabaya where the result of error measurement forecasting is greater than results in data comparison of the Number of Student data lab in the Reproduction Laboratory Livestock Faculty of Animal Husbandry University Brawijaya year 2010-2014.

4. CONCLUSION

From the discussion that has been done then it can be determined a conclusion as follows :

- 1) From the process of calculating the forecasting done to the practicum majors Technique Informatics University Bhayangkara Surabaya from the year 2010 - 2012 obtained forecasting results on year 2013 for practical subjects PTI amounted to -40, practical subjects ANP of -60, course practicum JARKOM for -20, course Database practicum of -25, eyes Manjarkom's practicum course is -20, PKG practicum course is 135 and PBO practicum courses are as big as -5. While on data comparison data Number of students who practicum at Laboratory Reproduction Livestock Faculty Farms University Brawijaya year 2010-2014 obtained forecasting

- results in 2015 for courses of biotechnology practice for 165 students and for the eyes college practicum of Livestock Reproduction Sciences amounting to 405 students.
- 2) Conditions on data of practicum participants majoring in Informatics Engineering University Bhayangkara Surabaya from the year 2010 - 2012 has an uneven amount or empty (zero) in the amount students who register lab so take effect on results forecasting becomes less precise and results can not in determining the forecasting.
 - 3) Mean error rate measurement Absolute Percentage Error (MAPE) in analyzing the accuracy of the method used in forecasting data participants follow practicum majors Technique Informatics University Bhayangkara Surabaya got value MAPE for PTI practicum course amounted to 20.50%, practicum course ANP of 0.50%, course JARKOM practicum of 8.50%, eyes college practicum Database of 0.50%, Manjarkom practicum course of 14.50%, the practical course PKG of 0.84% and courses practice PBO amount 0.21%. While on data comparison data Number of students who practicum at Laboratory Reproduction Livestock Faculty Farms University Brawijaya year 2010-2014 for the eyes Biotechnology lab course is as big as 1.65% and for the practicum course Animal Reproduction Science of 1.77% where the error measurement results forecasting is smaller than result on participant of practicum followers Department Technique Informatics University Bhayangkara Surabaya.
 - 4) If any new data used is not slightly with the projected upward trend in data. Then we can do the calculation process with the Fuzzy Time Series method become more appropriate for forecasting.

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