Grouping Student Awareness on Security Of E-Learning Information Using Fuzzy C-Means Method

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Abstract— Many educational institutions have been forced to adapt how they present the teaching and learning process, including the creation of appropriate learning media due to the current Covid-19 pandemic. This is accomplished through the development of an integrated online learning system known as E-Learning. Aside from all of the benefits and positive outcomes that E-Learning can give, there are also drawbacks to student information security, such as assignment theft, piracy of E-Learning, the misuse of passwords by irresponsible students, and other problems. To anticipate this, the researcher intended to group students' awareness of their respective E-Learning information security by using the Fuzzy C Means method. Fuzzy C Means uses a fuzzy grouping model so that data can be members of all classes or clusters formed with different degrees or levels of membership between 0 to 1. The sample used to represent the population is 20 students of STIKOM PGRI Banyuwangi, Indonesia. The results obtained are to find out how well the grouping of student awareness clusters on E-Learning information security. There are 3 clusters of student E-Learning information security awareness. Cluster 1 consists of students with high awareness, cluster 2 contains categories of students with low awareness, and the third cluster consists of students with moderate awareness.

Keywords— E-Learning, Information Security, Fuzzy C-Means, Clustering, Data.

I. INTRODUCTION

In this era, following technological developments is a must to not be left behind by the times. The desire to use technology is strongly influenced by perception. Perception is a process that starts from using the five senses in receiving a stimulus, and then it is organized and interpreted so that it understands what is sensed [1]. Previous research used the Fuzzy C-Means method for grouping student satisfaction levels on the learning process during a pandemic [2].

E-Learning is a learning process or teaching and learning process carried out electronically (remotely). Lecturers can provide teaching assignments through the E-Learning website, and students can access and collect learning outcomes on the website. STIKOM PGRI Banyuwangi has been using E-Learning for a long time. The easy access to the internet is accompanied by dangers about student information security, especially students of STIKOM PGRI Banyuwangi. One of the factors causing data theft in student E-Learning is that students forget to change their E-Learning password and easily spread their NIM (Student Identification Number) and password to their friends. With the evidence of these cases on information security, socialization is needed to increase knowledge of the importance of information security [3]. This study only focused on Information Security for E-Learning Students of STIKOM PGRI Banyuwangi. They had a goal to find out how well students' awareness of E-Learning security was.

According to PP RI No. 30 of 1990, students are students who are registered and studying at certain universities. Students are also agents of change or change agents where students are at the forefront of changing a nation. Even though STIKOM PGRI Banyuwangi is an IT campus, many students are still not aware of the security of their E-Learning. This is a necessity for students of STIKOM PGRI Banyuwangi. This research is the development of one of the learning media during the pandemic using Project-Oriented Problem-Based Learning (POPBL) [4].

Many researchers have taken advantage of the advantages of the Fuzzy C-Means method to complete case studies in the grouping, including grouping customer loyalty [5], grouping health service facilities [6], and grouping health care providers [7]. This study uses the Fuzzy C-Means quantitative method. This method is very suitable for use because FCM uses a fuzzy grouping model so that data can be members of all classes or clusters formed with different degrees or levels of membership between 0 to 1. This study is less risky than previous research [8].

This study aims to classify the level of student awareness of the information security of E-learning STIKOM PGRI Banyuwangi. This becomes very crucial and has benefited so that we can know and take the right steps to prevent unwanted things from happening. We can provide socialization regarding the security of their respective E-Learning information in the future.

II. RESEARCH METHODS

The method applied in this research is quantitative, which uses numerical data from the beginning to the end of the study.

A. Literature Review

1) Information Security: The definition of information security is an effort to secure information assets from all threats that may occur to reduce the negative risk received. The more information stored in an organization, the more risks, such as

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damage, loss, or personal information, can be spread to irresponsible parties [9].

2) E-Learning: E-Learning or Electronic-Learning is a learning process that utilizes technology, usually using the internet. STIKOM PGRI Banyuwangi students can attend lectures such as giving material by lecturers online attendance using E-Learning.

3) Clustering: The meaning of data mining is the grouping of a number of data or objects into clusters (groups). Each in the cluster will contain data as similar as possible and different from objects in other clusters. Scientists are still making various efforts to improve the cluster model and calculate the optimal number of clusters so that the best cluster can be produced [10].

4) Fuzzy C Means: Fuzzy C-means Clustering (FCM), also known as Fuzzy ISODATA, is a clustering method that is part of the Hard K-Means method. FCM uses a fuzzy grouping model so that data can be members of all classes or clusters formed with different degrees or levels of membership between 0 to 1 [11].

B. Research Stages

This research went through several stages, such as research preparation to concluding with the flow in Figure 1 [11].

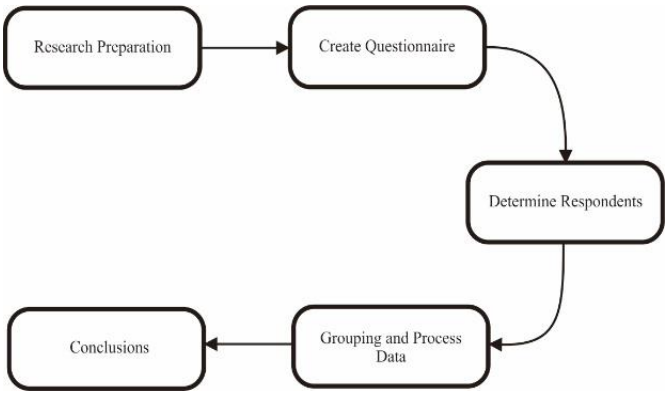

Figure 1. Research Stage

The stages of this research are as follows:

1) Research Preparation: In carrying out research, it is necessary to think about the background of the research, the problem formulation, the objectives to be achieved. It is essential to carry out field studies by looking at the problems that occur and theoretical studies.

2) Create Questionnaire: In making a questionnaire, the things that become the basis are problems that occur in real life.

3) Determine Respondents: It is essential to determine the respondents so that the research is directed and on target.

4) Grouping and Processing Data: After carrying out the questionnaire, the data from the respondents were processed using the Fuzzy C Means method.

5) Conclusions: Conclusions can be drawn if the reference results from data processing are known.

C. Data Collection

Researchers provide questionnaires to be answered by respondents based on Table I. There are several questionnaires to determine clusters [12]. Researchers provide 12 questions that respondents must answer. Questionnaires were distributed online and addressed to students of STIKOM PGRI Banyuwangi on E-Learning Information Security.

TABEL I
QUESTION FOR RESPONDENTS

Point	Question	Question Choice
Knowledge	E-Learning passwords may not be shared with anyone	5 is strongly agree
	Changing E-Learning password	4 is agree
	Not letting others access my E-Learning	3 is neutral
	Do not use E-Learning passwords that are easy for anyone to guess	2 is disagree
		1 is strongly disagree
Attitude	I am aware not to share my E-Learning password with anyone	
	I am aware not to access E-Learning using the public internet network	
	I am aware of the dangers of data theft in E-Learning	
	I am aware of using complex E-Learning Passwords	
Behavior	I am used to keeping my E-Learning passwords only for myself	
	I am used to using complex E-Learning passwords	
	I use extra security for my cell phone (lock screen, face id, pattern, pin, etc.)	
	I used to keep an eye on my cellphone in a place where I could directly monitor myself	

D. Population

A collection of the whole of which will be studied. In this case, the population is students of STIKOM PGRI Banyuwangi.

E. Sample

It is a collection of parts of the population that will be used. In this case, the researcher took a sample of 20 students representing the student population of STIKOM PGRI Banyuwangi.

F. Algoritma Fuzzy C Means

The Fuzzy C-Means (FCM) Algorithm can be structured with the following steps [13], [14], [11] :

1. Define the data set.
2. Determine the expected number of clusters using Equation (1),
   $1 < c < N$ (1)

   Where, weighting value $m > 1$, woith stop tolerance value using Equation (2)
   $\in > 0$, iterasi > 1 (2)
3. Initialize the partition matrix randomly using Equation (3),
   $U(0) \in M_{fc}$ (3)
   repeat for *1 = 3, 4, 5*
4. Calculate cluster center (Means).

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5. Calculate the distance.
6. Update partition matrix using Equation (4),
$$1 \leq k \leq N \quad (4)$$
Where, *if* $D_{ikA} > 0$ *for all i = 1,2,...c*
7. Repeat iteration till using Equation (5),
$$||(U)^{(i)} - (U)^{(i-1)}| < \varepsilon \quad (5)$$

The question above is divided into 3 clusters, so it is divided to determine the average. To calculate the objective function of a cluster, the formula is used Equation (6).

$$((x1 - c1)^2) - (x2 - c2)^2)) \; x \; Miu \quad (6)$$

Formula matrix partition U using Equation (7),

$$((x1 - c1)^2 - (x2 - c2)^{\left(-\frac{1}{2}-1\right)}) \quad (7)$$

The formula for calculating cluster center using Equation (8),

$$\sum \frac{Miu\ Kuadrat}{Miu} \quad (8)$$

Where *X1* variable is the 1st parameter, *X2* is the 2nd parameter, *C1* is the 1st cluster center, *C2* is the 2nd cluster center, and *Miu* is the 2nd average cluster.

III. RESULTS AND DISCUSSION

In this study, 20 samples were used from students of STIKOM PGRI Banyuwangi. The results of the questionnaire were obtained from questionnaires distributed to students online. Characteristics of respondents are as follows:
Gender of 20 respondents

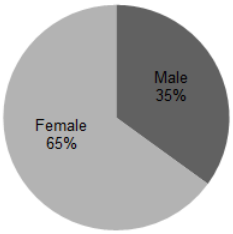

Figure 2. Percentage of Respondent's Gender

Based on the percentage above, as many as 35% of respondents are male or a total of 7 people. As many as 65% of respondents are female or 13 people. Before starting the data calculation, specify 1st and 2nd parameters for easy analysis.
1st parameters: Have you ever experienced theft of your data/answers in E-Learning?

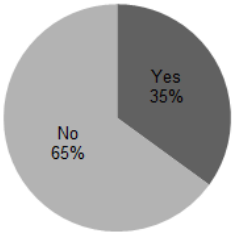

Figure 3. 1st Percentage of Parameter

Based on the parameters above, as many as 65% of respondents have never experienced theft/leakage of data/your answers in E-Learning. As many as 35% of respondents have experienced theft/leakage of your data/answers in E-Learning. This percentage is still relatively very large. This shows that there are still frequent thefts/leakages of your data/answers in E-Learning.
2nd parameter: If you experience theft of data/answers in E-Learning, do you feel disturbed about it?

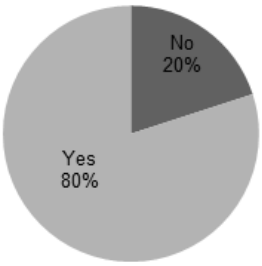

Figure 4. 2nd Percentage of Parameters

Based on the parameters above, as many as 80% of respondents feel disturbed when experiencing theft/leakage of data/answers in E-Learning. As many as 20% of respondents do not feel disturbed when experiencing theft/leakage of data/answers in E-Learning. Although the percentage is small, students still lack awareness of the security of their E-Learning information.

After knowing 1st parameters (*X1*) and 2nd parameters (*X2*), the parameter results are converted to values 1 (Yes) and 2 (No) for easy calculation [10].

TABEL II
PARAMETER CONVERSION

x1	*x2*
1	1
2	1
1	1
2	1
2	1
2	1
2	1
2	1
2	2
1	1
1	1
2	2
2	2
1	1
2	1
1	1
1	1
2	1
2	1
2	2

The first step after knowing the data from the questionnaire, the data is taken on average from 3 Clusters (Knowledge, Attitude, Behavior) to calculate iteration 1 [10]. Obtained the average as seen Table III

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TABEL III
CLUSTER AVERAGE

Knowledge	Attitude	Behavior
4,25	3,75	2,75
3	4,5	3,25
4,25	5	5
1	1,25	1
5	5	4
2	3	3
5	4,5	4
5	5	5
3	3	3
5	4,75	5
5	4,25	4,75
2,5	2,75	3,75
4,5	4	5
4	4	4
4,25	3,5	2,75
5	5	5
4,75	4,5	4,75
5	5	5
4	3,75	3,75
3	3	3

Determine the values needed to calculate Fuzzy C Means with the results as shown in Table IV.

TABEL IV
REQUIRED VALUE

Sum of Cluster	*c*	3
Rank	*w*	2
Maximum Iterations	*MaxIter*	100
Smallest Error Expected	*e*	0,0001

Input on processing affects the resulting output. The maximum value of iteration and the smallest error different affect members of each cluster but still produce the number of clusters according to the input. While rank affects the number of members in each cluster, it also affects the number of clusters [13]. Therefore, the researcher chose the rank value, the maximum iteration, and the smallest expected error, namely 2, 100, and 0.0001.

TABEL V
MIU KUADRAT TO ITERATION 1

Miu Kuadrat (Iteration 1)	*c1*	*c2*	*c3*
	18,0625	14,0625	7,5625
	9	20,25	10,5625
	18,0625	25	25
	1	1,5625	1
	25	25	16
	4	9	9
	25	20,25	16
	25	25	25
	9	9	9
	25	22,5625	25
	25	18,0625	22,5625
	6,25	7,5625	14,0625
	20.25	16	25
	16	16	16
	18,0625	12,25	7,5625
	25	25	25
	22,5625	20,25	22,5625
	25	25	25
	16	14,0625	14,0625
	9	9	9
Miu	342,25	334,875	324,9375

The next step is to increase the membership value of each Cluster (Miu Square) in Iteration 1 with the results as shown in Table I.

The next step, find the center of the Cluster. In the initial conditions, the center of this cluster is still not accurate. Each data point has a degree of membership for each cluster. How to fix the cluster center and the degree of membership of each data point repeatedly, it will be seen that the cluster center will move to the right location [13]. This iteration is based on the minimization of the objective function, which describes the distance from a given data point to the center of the cluster, the distance weighted by the membership of the data point.

Step 1: multiplying the data value with the membership rank value with the results as shown in Table VI.

TABEL VI
MULTIPLE THE RESULT OF DATA VALUE WITH THE VALUE OF MEMBERSHIP RANK

x1c1	*x1c2*	*x1c3*	*x2c1*	*x2c2*	*x2c3*
18,0625	14,0625	7,5625	18,0625	14,0625	7,5625
18	40,5	25,125	9	20,25	10,5625
18,0625	25	25	18,0625	25	25
2	3,125	2	1	1,5625	1
50	50	32	25	25	16
8	18	15	4	9	9
50	10,5	32	25	20,25	16
50	50	50	25	25	25
18	18	18	18	18	18
25	22,5625	25	25	22,5625	25
25	18,0625	28,5625	25	18,0625	22,5625
12,5	15,125	28,125	12,5	15,125	28,125
40,5	32	50	40,5	32	50
16	16	16	16	16	16
36,125	24,5	15,125	18,0625	12,25	7,4625
25	25	25	25	25	25
22,5625	20,25	22,5625	22,5625	20,25	22,5625
50	50	50	25	25	25
32	28125	28,125	16	12,0625	14,0625
18	18	18	18	18	18
534,8125	528,8125	506,1875	386,75	376,4375	382

Step 2: calculate the Cluster value based on the value obtained so that the value is obtained with the results as shown in Table VII.

TABEL VII
ITERATION CLUSTER CENTER 1

Cluster Center	
x1	***x2***
1,562637	1,130022
1,579134	1,124113
1,5578	1,175611

Step 3: calculate the Objective function. This calculation requires Parameters, Cluster Center, Miu Square. Obtained results are in Table VIII.

TABELVIII
ITERATION OBJECTIVE FUNCTION 1

Objective Function			
Ll	***L2***	***L3***	***LT***
6,102536	5,493863	10,33193	21,92832
5,977262	5,335694	10,21633	21,52918
6,102536	5,493863	10,33193	21,92832

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Objective Function			
Ll	***L2***	***L3***	***LT***
5,977262	5,335694	10,21633	21,52918
5,977262	5,335694	10,21633	21,52918
5,977262	5,335694	10,21633	21,52918
5,977262	5,335694	10,21633	21,52918
5,977262	5,335694	10,21633	21,52918
259,2273	257,0856	221,0288	737,3417
6.102636	5,493863	10,33193	21,92832
6.102636	5,493863	10,33193	21,92832
259,2273	257,0856	221,0288	737,3417
259,2273	257,0856	221,0288	737,3417
6.102536	5 493863	10 33193	21,92832
5,977262	5,335694	10,21633	21,52918
6.102536	5,493863	10 33193	21,92832
6.102536	5,493863	10 33193	21,92832
5,977262	5,335694	10,21633	21,52918
5,977262	5,335694	10,21633	21,52918
259,2273	267 0856	221.0288	737,3417
	Objective Function:		**3296,628**

Step 4: calculate the Objective Function Difference Iteration 1 to determine whether the iteration has stopped or is continuing with the results as shown in Table IX.

TABEL IX
ITERATION OBJECTIVE FUNCTION DIFFERENCE 1

Difference Objective Function	
P1	3296,628
P0	0
P1 – P0	3296,628

Because the smallest expected error is 0.0001, and the Objective Function Difference Iteration 1 is greater than the smallest expected error, then the iteration continues to Iteration 2 [15]. Calculate the *U* Partition Matrix with the results in Table X.

TABEL X
PARTITION MATRIX U CALCULATION

Partition Matrix U			
L1	**L2**	**L3**	**LT**
5,360825	4,732995	7,378458	17,47228
16,32266	18,86269	50,17431	85,35966
5,360825	4,732995	7,378458	17,47228
16,32266	18,86269	50,17431	85,35966
16,32266	18,86269	50,17431	85,35966
16,32266	18,86269	50,17431	85,35966
16,32266	18,86269	50,17431	85,35966
16,32266	18,86269	50,17431	85,35966
0,942272	0,949654	0,980459	2,872385
5,360825	4,732995	7,378458	17,47228
5,360825	4,732995	7,378458	17,47228
0,942272	0,949654	0,980459	2,872385
0,942272	0,949654	0,980459	2,872385
5,360825	4,732995	7,378458	17,47228
16,32266	18,86269	50,17431	85,35966
5,360825	4,732995	7,378458	17,47228
5,360825	4,732995	7,378458	17,47228
16,32266	18,86269	50,17431	85,35966
16,32266	18,86269	50,17431	85,35966
0,942272	0,949654	0,980459	2,872385
		LT:	**902,0324**

Step 5: calculate the new membership data based on the partition matrix for Iteration 2 with the results in Table XI.

TABEL XI
NEW MEMBERSHIP DATA

New Membership Data			
	L1/L2	***L2/LT***	***L3/LT***
1	0,306819	0,270886	0,422295
2	0,191222	0,220979	0,587799
3	0,306819	0,270886	0,422295
4	0,191222	0,220979	0,587799
5	0,191222	0,220979	0,587799
6	0,191222	0,220979	0,587799
7	0,191222	0,220979	0,587799
8	0,191222	0,220979	0,587799
9	0,328045	0,330615	0,34134
10	0,306819	0,270886	0,422295
11	0,306819	0,270886	0,422295
12	0,328045	0,330615	0,34134
13	0,328045	0,330615	0,34134
14	0,306819	0,270886	0,422295
15	0,191222	0,220979	0,587799
16	0,306819	0,270886	0,422295
17	0,306819	0,270886	0,422295
18	0,191222	0,220979	0,587799
19	0,191222	0,220979	0,587799
20	0,328045	0,330615	0,34134

Step 6: calculate the Cluster center in Iteration 2 with the results in Table XII.

TABEL XII
ITERATION CLUSTER CENTER 2

Cluster Center	
x1	***x2***
1,535454	1,288385
1,329843	6,041267
0,469963	1,096612

Repeating the same process is to find the objective function iteration 2 with the results as shown in Table XIII.

TABEL XIII
ITERATION OBJECTIVE FUNCTION 2

Objective Function			
Ll	**L2**	**L3**	**LT**
0,524675	35,48653	1,400265	37,41146548
0,424092	35,95969	11,33796	47.72174169
0,524675	35,48653	1,400265	37,41146548
0,424092	35,95969	11,33796	47.72174169
0,424092	35,95969	11,33796	47.72174169
0,424092	35,95969	11,33796	47.72174169
0,424092	35,95969	11,33796	47.72174169
0,424092	35,95969	11,33796	47.72174169
1,024448	23,33165	15,22981	39,58590632
0,524675	35,48653	1,400265	37,41146548
0,524675	35,48653	1,400265	37,41146548
1,024448	23,33165	15,22981	39,58590632
1,024448	23,33165	15,22981	39,58590632
0,524675	35,48653	1,400265	37,41146548
0,424092	35,95969	11,33796	47.72174169
0,524675	35,48653	1,400265	37,41146548
0,524675	35,48653	1,400265	37,41146548
0,424092	35,95969	11,33796	47.72174169
0,424092	35,95969	11,33796	47.72174169
1,024448	23,33165	15,22981	39,58590632
		Objective Function:	**849,7195589**

Step 7: calculate the difference in the objective function of iteration 2 to determine whether the iteration has stopped or is continuing with the results as shown in Table XIV. Because the

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result of the difference in the objective function is less than the expected smallest error (0.0001), iteration two stops.

TABEL XIV
ITERATION OBJECTIVE FUNCTION DIFFERENCE 2

Objective Function Difference	
P2	849,7196
P1	3296,628
P2 – P1	-2446,91

Step 8: Calculate the Partition Matrix U with the results shown in Table XV.

TABEL XV
PARTITION MATRIX CALCULATION U

Partition Matrix U		
L1	L2	L3
2,703603	0,03918	3,445028
3,344824	0,038665	0,425469
2,703603	0,03918	3,445028
3,344824	0,038665	0,425469
3,344824	0,038665	0,425469
3,344824	0,16655	0,003255
3,344824	0,038665	0,425469
3,344824	0,001912	0,425469
1,38466	0,059591	0,316744
2,703603	0,03918	3,445028
2,703603	0,002488	3,445028
1,38466	0,059591	0,316744
1,38466	0,059591	0,316744
2,703603	0,03918	3,445028
0,025765	0,038665	0,0044535
2,703603	0,03918	3,445028
2,703603	0,03918	3,445028
3,344824	0,038665	0,425469
3,344824	0,038665	0,425469
1,38466	1,593525	0,001524

Step 9: calculate the degree of membership based on the partition matrix results in Table XVI.

TABEL XVI
MEMBERSHIP DEGREE

Data To-	Membership Degree			Selected CLuster	Cluster
	1	2	3		
1	2,703603	0,03918	3,445028	3,4445028	3
2	3,3344824	0,038665	0,425469	3,344824	1
3	2,703603	0,03918	3,445028	3,4445028	3
4	3,3344824	0,038665	0,425469	3,344824	1
5	3,3344824	0,038665	0,425469	3,344824	1
6	0,014323	0,16655	0,003255	0,16655	2
7	3,3344824	0,038665	0,425469	3,344824	1
8	3,3344824	0,001912	0,425469	3,344824	1
9	1,38466	0,059591	0,316744	1,38466	1
10	2,703603	0,03918	3,445028	3,4445028	3
11	2,703603	0,002488	3,445028	3,4445028	3
12	1,38466	0,059591	0,316744	1,38466	1
13	1,38466	0,059591	0,316744	1,38466	1
14	2,703603	0,03918	3,445028	3,4445028	3
15	0,025765	0,038665	0,004535	0,038665	2
16	2,703603	0,03918	3,445028	3,4445028	3
17	2,703603	0,03918	3,445028	3,4445028	3
18	3,3344824	0,038665	0,425469	3,344824	1
19	3,3344824	0,038665	0,425469	3,344824	1
20	1,38466	1,593525	0,001524	1,593525	2

The iteration process in Figure 5 has been completed. Based on the table above, it can be concluded that there are 3 Clusters, with membership as follows :

- C1 (Cluster with High Awareness) = Data to 2, 4, 5, 7, 8, 9, 12, 13, 18, 19
- C3 (Cluster with Moderate Awareness) = Data to 1, 3, 10, 11, 14, 16, 17.
- C2 (Cluster with Low Awareness) = Data to 6, 15, 20.

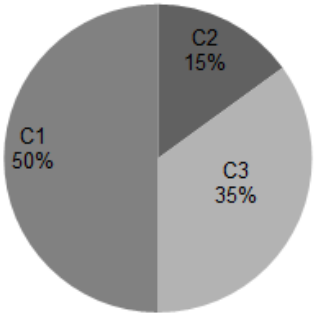

Figure 5. Percentage of Student Awareness Cluster

After doing the above calculations, it can be concluded that based on 20 samples of STIKOM PGRI Banyuwangi students, there are three levels of E-Learning information security awareness clusters. *C1* (Cluster with High Awareness) with a percentage of 50%, *C3* (Cluster with Moderate Awareness) with a percentage of 35%, *C2* (Cluster with Low Awareness) with a percentage of 15%.

A study stated that the K-Means Clustering algorithm can group data in the same group and different data in different groups [10]. A study states that this method can perform grouping for data that is scattered irregularly [13]. A study [8] said that his research used experimental methods on E-learning users. The final result of the study is to identify the level of user awareness of the security of the e-learning system [9]. A study conducted stated that the advantage of FCM is that it can cluster more than one variable at once. FCM applies fuzzy grouping, where each data can be a member of several clusters with different degrees of membership in each cluster [16]. The previous studies have the same goal: to identify and classify information security. This study has the advantage of being less risky, and the calculations that the researcher did are correct so that the cluster results obtained are the best.

IV. CONCLUSION

Fuzzy C Means can perform the clusterization process on the research sample data at STIKOM PGRI Banyuwangi. The best cluster results on student E-Learning information security awareness data are 3 clusters. Based on the calculation results, cluster 1 is filled with students with high awareness of 11 data; cluster 2 is filled with students with low awareness of 3 data; cluster 3 is filled with students with moderate awareness of 7 data.

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