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# Convolutional Neural Network and Support Vector Machine in Classification of Flower Images

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**Abstract**-Flowers are among the raw materials in many industries including the pharmaceuticals and cosmetics. Manual classification of flowers requires expert judgment of a botanist and can be time consuming and inconsistent. The ability to classify flowers using computers and technology is the right solution to solve this problem. There are two algorithms that are popular in image classification, namely Convolutional Neural Network (CNN) and Support Vector Machine (SVM). CNN is one of deep neural network classification algorithms while SVM is one of machine learning algorithm. This research was an effort to determine the best performer of the two methods in flower image classification. Our observation suggests that CNN outperform SVM in flower image classification. CNN gives an accuracy of 91.6%, precision of 91.6%, recall of 91.6% and F1 Score of 91.6%.

**Keywords:** flower classification, convolutional neural network, support vector machine, machine learning, deep neural network

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## 1. Introduction

Flowers are God's creation that have long been admired to resemble beauty and romance because of their diverse shapes and colors. Flowers are objects of esotericism, witchcraft, medicine, and source of food. Many industries pick flowers as raw materials. Numerous use of flowers and their huge diversity leads to the need of flower classification. Classifying flowers is a strenuous and painstaking task and requires expertise of a botanist. The ability to utilize computer software and technology in flower image classification will greatly help the pharmaceutical, cosmetic and other industries.

Flower image classification has invited many researchers to investigate new methods to obtain accurate results. Among the methods are deep learning and neural networks, which are experiencing rapid progress in artificial intelligence and innovation. The methods have taken a huge leap in recent years and is capable of surpassing humans in several tasks related to detecting and labeling objects.

Convolutional Neural Network (CNN) is one of the most widely used deep learning method, compared

to several image processing methods [1]. CNN has solved some of the categorization problems of real-life object images. This method is relatively easy and flexible so that it is easy to integrate into various platforms. However, the convenience and advantages of this method have the consequence of providing hardware with high capabilities to obtain the desired model [2]. CNN processes images in the same way as the human brain, namely by teaching and learning [3]. Image classification is done by labeling images. Furthermore, with certain equations, the computer begins to classify.

Besides CNN, another method that can be used in image classification is the Support Vector Machine (SVM). SVM is the best and uncomplicated initial classification method [4]. SVM works by defining the boundary between two classes with the maximum distance from the closest data. The maximum distance is obtained by finding the best hyperplane (separation line) in the input space obtained by measuring the hyperplane margin.

When in a high-dimensional input space, SVM still has good generalizability without additional knowledge. This is the advantage of SVM. The weakness of SVM is that its use is limited to linear data. For use with non-

linear data, modifications to the kernel function are required.

Color is one of the most dominant characteristics of flowers. Research related to color in flower images has been carried out by [5] who classifies flowers using the SVM method. The classification results are very good with an accuracy of 85.93%. By applying Artificial Neural Networks (ANN), [6] has carried out pre-processing activities to improve image quality, segmentation and feature extraction. The pre-processing step gives classification results with an accuracy of 81.19%. Research on flower classification using CNN has also been carried out by [7] and the model created produces an overall accuracy of 90% and is able to make predictions in real time of 98%. Meanwhile, [8] in his research conducted flower image classification with CNN, conducted a validation test with k-fold cross validation, and got the highest average accuracy of 76.49%.

So far, there has never been a comparison of the results of flower image classification using Deep Neural Network and classical Machine Learning methods to find out which method shows the best performance. Previous

studies have focused more on the classification process in one method only.

## 2. Method

This research was carried out in several stages, namely processing the initial image data (pre-processing), sharing training and testing data, making classification models using CNN and SVM methods, evaluating classification models, results of performance comparisons between classification models, and drawing conclusions. The stages of the research method can be seen in Figure 1.

### a. Dataset

The images or objects used as datasets in this study are roses, tulips and aster. The total dataset used is 1200, and was obtained randomly using Google image. The data in the Rose category are 400, Tulip flowers are 400 and Aster flowers are 400. The data in each category is divided into training data and testing data with details of 80% training data and 20% testing data [9]. Table 1 presents the method of dividing the dataset that has been done.

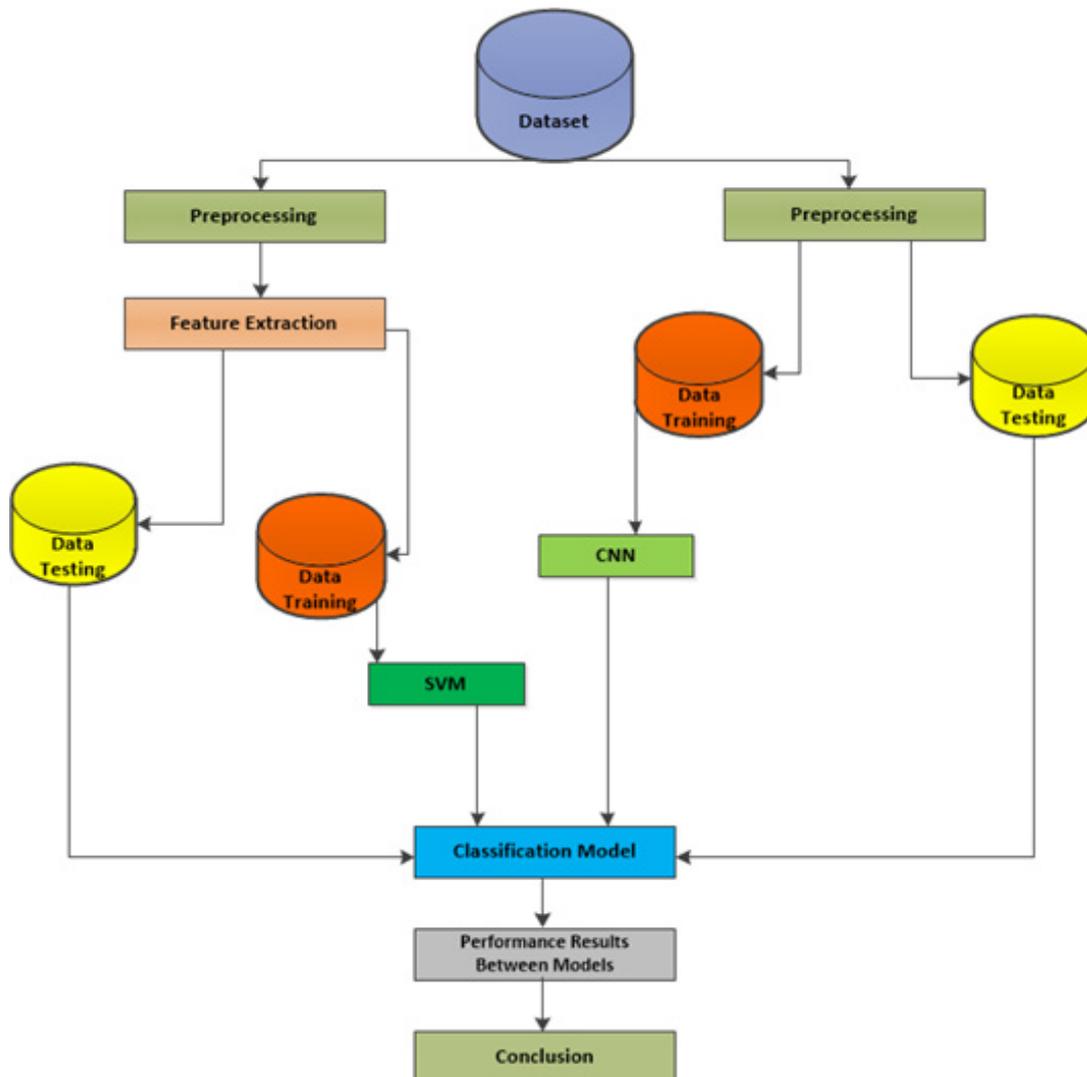


Figure 1. Research Method

**Table 1. Dataset Sharing**

Category	Total	Train	Test
Rose	400	320	80
Tulips	400	320	80
Aster	400	320	80

### b. Preprocessing Data

Image quality can be improved by pre-processing. Noise removal and determination of the part of the image to be used are some of the methods used in pre-processing. Unwanted outer areas can be removed so as to make the image focus better and more uniform, this technique is also known as cropping [10].

As a research test material, good image quality is a must so that the classification results are more optimal, so noise cleaning is one thing that absolutely must be done. Noise is a disturbance in the image that does not reflect the true intensity of the actual scene [11].

All images must have the same size, so the image must be reshaped before modeling. Simple resizing can be done manually by stretching and changing the ratio of each image and then forcing it to a new size. The size of the input image must be chosen which is the most effective for use in classification, because a larger image input will result in a longer classification process, while a smaller image input makes the classification process faster [12]. This study uses an image with a size of 200x200 pixels. An example of an image after preprocessing is shown in Figure 2.

**Figure 2. Image after preprocessing**

### c. Classification Modeling

Classification modeling is carried out before data processing to determine what parameters are used in the algorithm. The goal is to determine the effect of the parameters on the resulting performance and get the best parameters.

In this research, CNN uses several parameters, namely Epochs, layer depth, and activation layer. The function used for activation is ReLU (Rectified Linear Unit). The number of selected Epochs is 20. The layers used are 4 layers and each layer uses a 3 x 3 kernel. Convolution filters for each layer are 16 in the first layer, 16, 32 in the second layer, 64 in the third layer and 128 in the fourth layer.

On CNN there is a pooling process that is used to reduce the dimensions of the image to the convoluted model which is a type of Non-Linear Down Sampling. The max pooling kernel size used in this research is 2 x 2. In order to avoid overfitting, it is necessary to add the Combined L2 + Dropout parameter, the Dropout value is 0.5 then the L2 value is 0.0001. Dense is the last parameter

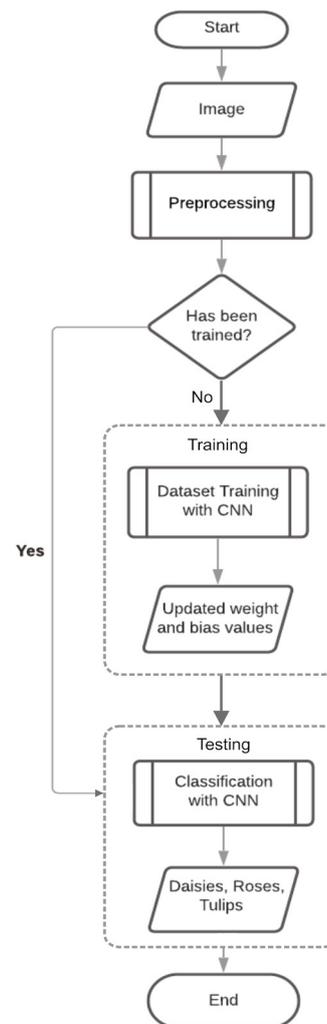
in the classifier network, totaling 3 layers with the number of neurons in each layer is 256, 256 and 128 neurons.

SVM uses several parameters, including the toll, which is the tolerance value that is used as a determinant of when the classification will stop. The toll value used in this study is 0.001.

Feature extraction and preprocessing are performed to transform data from image matrix to vector. The results of the transformation are used as input for the SVM classification which consists of 16 texture features.

### d. Convolutional Neural Network

Image classification using the CNN method is carried out in two stages. The first stage is the training process and the second stage is the testing process. Feature extraction in the CNN method is carried out by performing the convolution, ReLU, maxpooling and flatten processes using the image as input. The features generated from this process are different from those generated by GLCM (Gray Level Co-occurrence Matrix) in feature extraction. The CNN method that will be used can be described with a flowchart as shown in Figure 3.

**Figure 3. Process flowchart with CNN**

### e. Support Vector Machine

SVM classification is divided into two stages, namely the training process and the testing process. The training process is carried out after the image undergoes a process of separating background and foreground. The purpose of this stage is that the RGB color is still owned by the foreground and the white color is owned by the background. [13]. The image is then segmented, namely by dividing the image into several areas or objects [14]. In this research, segmentation is done using edge detection. The segmented flower image is used as input for feature extraction data to facilitate the texture feature extraction process. GLCM is used to perform texture feature extraction. The stages of using the SVM method can be modeled with a flowchart as shown in Figure 4.

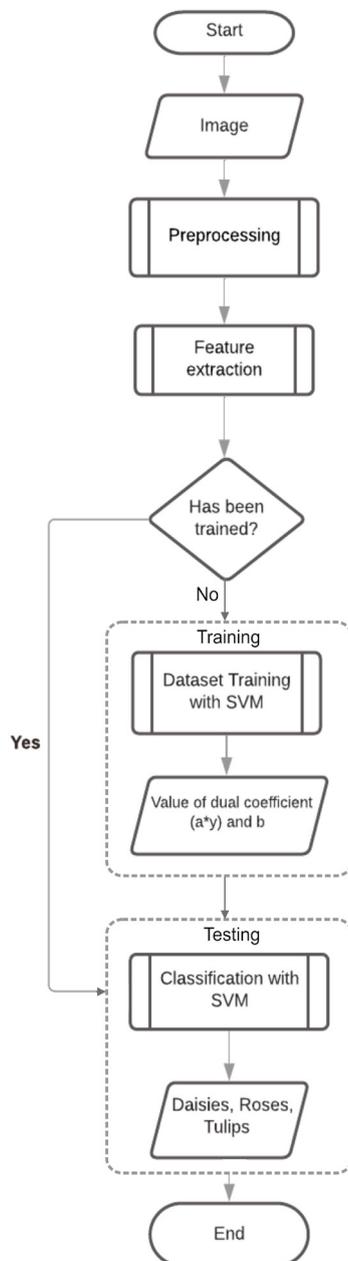


Figure 4. Process flowchart with SVM

### f. Classification Model Evaluation

Measuring the performance of the created model is an important step in machine learning. The classification results from a classification model are usually summarized in a confusion matrix. According to [15], test data that are not used in training can be used as an evaluation. Evaluation of the classification model is done by looking at the performance of the classification model. The metrics used are accuracy, precision, recall and F1 score. Accuracy is used to see the percentage of the number of data items that are classified correctly by the system [16]. Equation 1 calculates accuracy.

$$\text{Accuracy} = \frac{TP + TN}{\text{Total Data}} \quad (1)$$

The level of suitability of the information provided by the system and the information required by the user is also called precision, while the success rate of the system in finding information is recall [17]. Equation 2 and equation 3 are used to calculate precision and recall.

$$\text{Precision} = \frac{TP}{TP + FP} \quad (2)$$

$$\text{Recall} = \frac{TP}{TP + FN} \quad (3)$$

F1 Score, is the average formula of the correct recall value and precision value [18]. Equation 4 calculates the F1 score.

$$F1 = 2 \frac{\text{Precision} * \text{Recall}}{\text{Precision} + \text{Recall}} \quad (4)$$

## 3. Result

### a. CNN

Modeling with CNN was done in 20 Epochs. The model generated in the 20th epoch provides 91.67% accuracy, 2.59% loss, 91.67% precision, and 92% recall as shown in Figure 5.

Figure 6 shows a graph of changes in Accuracy, Loss, Precision and Recall values during the modeling and classification process with CNN. The loss function is overfitting in the 3rd epoch as indicated by the loss function value of 26.13% while the validation loss value is 74.70%. The loss value indicates the amount of variation in the training data. As the epoch increases, the loss decreases, which means that the error in the model becomes smaller, so that the final loss is 1.54%.

The summary of the classification results shows the final value of precision, recall, and other metrics for each category. The classification summary for the CNN model is shown in Figure 7.

Confusion Matrix classification results with CNN can be seen in Figure 8. It can be seen that for each class, there are many images that were successfully predicted well, namely 73 out of 80 for Aster class, 71 out of 80 for Mawar class, and 76 out of 80 for Tulip class. Based on equation (1), the accuracy value of classification with CNN is  $(73 + 71 + 76) / 240 = 0.916$  or 91.6%.

```

Epoch 11/20
960/960 [=====] - 126s 131ms/step - loss: 0.1505 - accuracy: 0.9678 - precision: 0.9657 - recall: 0.97
02 - val_loss: 0.0259 - val_accuracy: 0.9333 - val_precision: 0.9333 - val_recall: 0.9333
Epoch 12/20
960/960 [=====] - 126s 131ms/step - loss: 0.1522 - accuracy: 0.9676 - precision: 0.9654 - recall: 0.97
03 - val_loss: 0.0241 - val_accuracy: 0.9333 - val_precision: 0.9333 - val_recall: 0.9361
Epoch 13/20
960/960 [=====] - 125s 130ms/step - loss: 0.1550 - accuracy: 0.9678 - precision: 0.9648 - recall: 0.96
95 - val_loss: 0.0229 - val_accuracy: 0.8125 - val_precision: 0.8083 - val_recall: 0.8136
Epoch 14/20
960/960 [=====] - 126s 131ms/step - loss: 0.1526 - accuracy: 0.9671 - precision: 0.9650 - recall: 0.96
96 - val_loss: 0.0216 - val_accuracy: 0.9417 - val_precision: 0.9417 - val_recall: 0.9417
Epoch 15/20
960/960 [=====] - 125s 131ms/step - loss: 0.1468 - accuracy: 0.9699 - precision: 0.9675 - recall: 0.97
17 - val_loss: 0.0206 - val_accuracy: 0.9458 - val_precision: 0.9458 - val_recall: 0.9458
Epoch 16/20
960/960 [=====] - 126s 131ms/step - loss: 0.1412 - accuracy: 0.9678 - precision: 0.9661 - recall: 0.96
95 - val_loss: 0.0195 - val_accuracy: 0.9250 - val_precision: 0.9250 - val_recall: 0.9250
Epoch 17/20
960/960 [=====] - 127s 132ms/step - loss: 0.1416 - accuracy: 0.9662 - precision: 0.9642 - recall: 0.96
83 - val_loss: 0.0184 - val_accuracy: 0.9125 - val_precision: 0.9125 - val_recall: 0.9158
Epoch 18/20
960/960 [=====] - 126s 131ms/step - loss: 0.1538 - accuracy: 0.9654 - precision: 0.9631 - recall: 0.96
72 - val_loss: 0.0184 - val_accuracy: 0.9250 - val_precision: 0.9250 - val_recall: 0.9250
Epoch 19/20
960/960 [=====] - 126s 131ms/step - loss: 0.1540 - accuracy: 0.9667 - precision: 0.9646 - recall: 0.96
87 - val_loss: 0.0173 - val_accuracy: 0.9292 - val_precision: 0.9292 - val_recall: 0.9292
Epoch 20/20
960/960 [=====] - 124s 129ms/step - loss: 0.1730 - accuracy: 0.9622 - precision: 0.9593 - recall: 0.96
51 - val_loss: 0.0259 - val_accuracy: 0.9167 - val_precision: 0.9167 - val_recall: 0.9200
    
```

Figure 5. Results of the training process with CNN

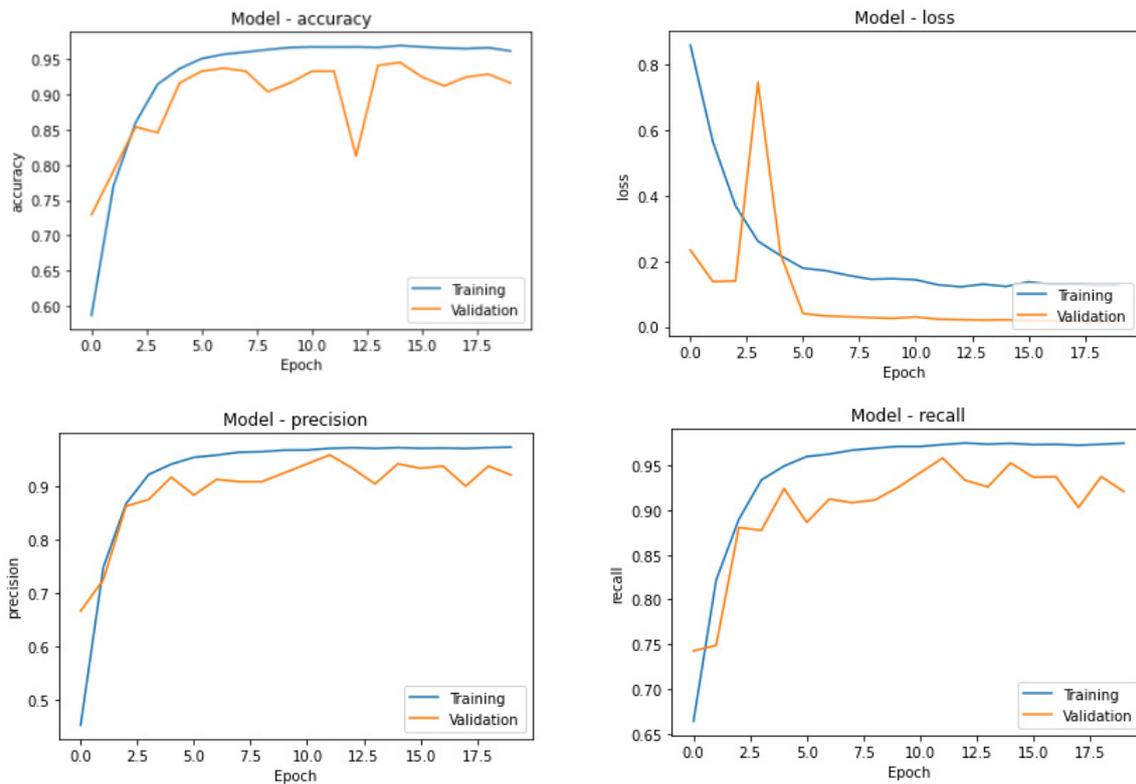


Figure 6. Accuracy, Loss, Precision and Recall Charts with CNN

Classification Report				
	precision	recall	f1-score	support
Daisies	0.92	0.91	0.92	80
Rose	0.91	0.89	0.90	80
Tulip	0.92	0.95	0.93	80
accuracy			0.92	240
macro avg	0.92	0.92	0.92	240
weighted avg	0.92	0.92	0.92	240

Figure 6. CNN Report Classification

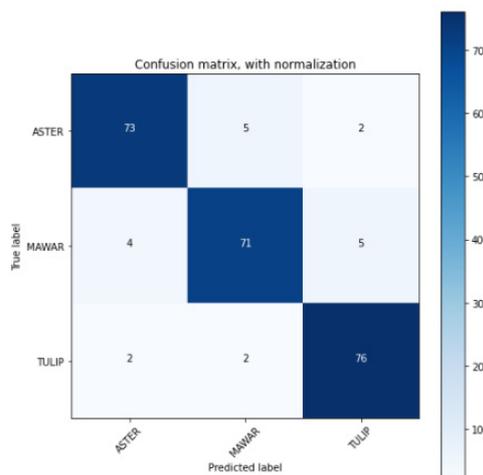


Figure 7. Confusion matrix CNN

### b. SVM

Image classification using the SVM method produces accuracy, f1-score, precision and recall values as shown in Figure 9. The classification process with this method provides a Confusion Matrix as shown in Figure 10, with correct predictions for the Aster class of 63, the Mawar class of 64, and Tulip grade of 61.

	precision	recall	f1-score	support
Aster	0.83	0.79	0.81	80
Mawar	0.74	0.80	0.77	80
Tulip	0.79	0.76	0.78	80
accuracy			0.78	240
macro avg	0.79	0.78	0.78	240
weighted avg	0.79	0.78	0.78	240

Figure 8. SVM Report Classification

The accuracy of the classification with SVM can be calculated based on equation (1) by adding up all the data that are True Positive (TP) and True Negative (TN), then dividing the result of the summation by the total number of data. In this way the accuracy is obtained  $(63 + 64 + 61) / 240 = 0.783$  or 78.3%.

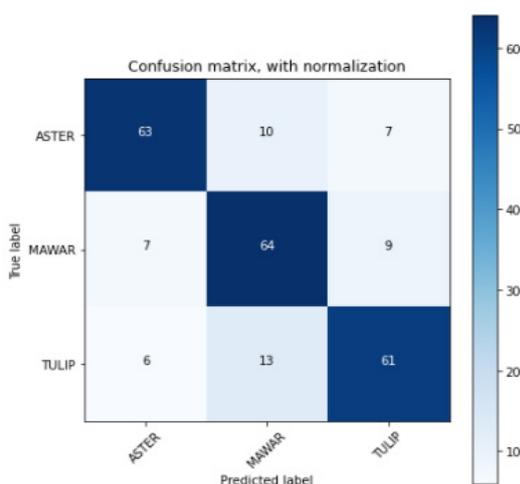


Figure 9. Confusion matrix SVM

### c. Comparison

Classification with CNN and with SVM results in different performance. Table 2 presents the performance of both methods for the four metrics measured. The table shows that the classification carried out using the CNN model is in the range of 91.6% for the values of accuracy, precision and recall. Meanwhile, the classification performance using the SVM method provides a lower accuracy of 78.3%, and lower precision and recall values of 78.6% and 78.3%, respectively.

Table 2. Performance data comparison

Method	Metric	Result
CNN	accuracy	0.916
	precision	0.916
	recall	0.916
	f1 score	0.916
SVM	accuracy	0.783
	precision	0.786
	recall	0.783
	f1 score	0.786

Various studies have shown that higher accuracy is obtained when using the CNN model. In the study [7], the CNN classification gave an accuracy value of 90%. Classification using the SVM method in research [5] gives an accuracy value of 85.93, which means it is lower than the results of classification using the CNN model. Some researchers have tried to combine the CNN model for feature extraction and machine learning for the classification process. The use of the hybrid method in research [19] and [20] showed a high classification performance with an accuracy value above 98%.

## 4. Conclusion

Our investigation shows that the CNN model performance for flower classification gives an accuracy value of 91.6%, precision of 91.6%, recall of 91.6% and F1 Score of 91.6%. The classification with SVM produces lower performance values, where accuracy attains a value at the level of 78.3%, precision at 78.6%, recall at 78.3% and F1 Score at 78.6%. The result suggests that CNN model outperforms SVM methods in flower classification tasks.

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# Divorce Fact Detection Based on Internet User Behavior Using Hybrid Systems with Combination of Apriori Algorithm and K-Means Method

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**Abstract**-An ideal couple should sustain the family's ark till the end of their life without divorce. This study aims at seeking the association between divorce and internet behavior of searching negative keywords. The study observes four keywords, which are porn, sex, gay, and lesbian. We collected keyword usage data from google trend reports and obtained divorce court figures from the Religion Court of Padang. We used the apriori algorithm to reveal the association between divorce and internet behavior observing individual keyword searches and in groups. We used the K-Means algorithm in classifying negative word searches and divorce trial numbers from a group of existing data. We also investigate the combination of the apriori algorithm and the K-Means method to detect divorce facts and the behavior of internet users. The combined method has been successful in revealing the positive association between divorce facts and the behavior of internet users.

**Keywords:** apriori algorithm, K-Means method, hybrid system, internet user behavior

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## 1. Introduction

When a man loves a woman they have the intention to get married and create a family [1]. A family is the smallest community of society. A minimum family consists of a man and a woman. Usually, a family lives in a house together and settles down somewhere.

Every family wants to be happy and prosperous living in the world and the hereafter. One of the indicators of happiness is that the family integrity is built until the end of life or separating by the death. However, for one reason or other unexpected things, married couples are unable to maintain life harmony. Many families have to separate and break away. Sometimes, there are quarrels and fights in the house. This is indeed undesirable because it can be the forerunner of separation or divorce [2].

Divorce is something that is permitted but hated by Allah. Divorce is an indicator of the success of Satan's work and the best achievements of Satan in seducing humans. There are many temptations that Satan has thrown at humans, especially for a married couple who have formed a family. Satan is very happy when a family gets divorced. Satan will do everything in his power so that a legal couple who has a family will separate or divorce as soon

as possible. This was done by Satan because Allah SWT really hates divorce. For this reason, as a Muslim husband and wife it is highly recommended to be able to maintain the integrity of a family that has been fostered with all their might, not to divorce until the end of life separates. That is an example of an ideal Muslim family couple in Islam [3].

Many things and factors cause a family divorce. These factors directly or indirectly influence divorce. Among these factors are economic factors, social factors, personality mismatch, third person, lack of faith, behavior, and so on. These factors contribute greatly to the causes of divorce. If we can minimize or eliminate these causative factors, the number of divorce cases will certainly be low and very small. On the other hand, if these factors are getting bigger and often done, then the divorce case will increase or get bigger. Table 1 shows the facts of divorce that occurred in Padang City, West Sumatra Province.

One of the big causes of family divorce is behavior. This behavior can be done in real or virtual daily habits. One type of behavior that is done by a husband or wife who has a very big influence is behavior in surfing the internet. There are two types of behavior in the internet world, namely positive behavior, and negative behavior. Positive behavior that is carried out will have a positive

impact on the person who does it while negative behavior will hurt the person who does it. This negative behavior is like frequently searching for negative information. In the internet world, there is all the desired information, regardless of type, it can be positive information and it can be negative information [4] - [6].

**Table 1. Number of Divorce Court Cases in Padang City, West Sumatra Province from August 2018 - July 2020**

No	Month	Number of Divorce Trial
1	August 2018	210
2	September 2018	138
3	October 2018	144
4	November 2018	100
5	December 2018	71
6	January 2019	215
7	February 2019	142
8	March 2019	150
9	April 2019	111
10	May 2019	86
11	June 2019	111
12	July 2019	211
13	August 2019	148
14	September 2019	128
15	October 2019	137
16	November 2019	114
17	December 2019	16
18	January 2020	265
19	February 2020	162
20	March 2020	121
21	April 2020	19
22	May 2020	34
23	June 2020	207
24	July 2020	157
Sum		3197

Negative information that is often searched by the internet, based on the google trend report page, is a search with the keywords porn, sex, gay and lesbian. The four negative keywords are often searched for by world internet users, even in Indonesia. The four negative keywords above when searched on the Internet will display negative information as well. Table 2 shows the data on the number of negative keyword searches from the four words above based on the google trend report.

Apriori algorithm is one of the algorithms in data mining science. A algorithm functions to see the appearance of data in a large group of data. This algorithm can also be used to calculate the appearance of data pairs in a large data set. This algorithm is suitable for viewing frequent items and frequent itemset from data. In this study, the apriori algorithm is used to calculate the occurrence of the words porn, sex, gay, and lesbian individually, in pairs 2, in

pairs 3, and pairs 4 from all the data on the appearance of these data in the behavior of internet users [7] - [9].

The K-Means method is one of the algorithms in data mining science. The K-Means method is a method used to group data (clustering) from several existing data and then look at the relationship between several data attributes and other data attributes. The K-Means method is often used to make it easier to read the influence of a variable with other variables because large amounts of data are clustered properly. In this study, the K-Means method was used to classify the number of keyword searches as porn, sex, gay, lesbian, and the number of trial sessions [10] - [12].

Based on the figures in table 1 and table 2 above, it can be seen that the number of divorce hearings is quite high in Padang City, West Sumatra province and also the number of negative keyword searches is high. In this study, two methods were combined, namely the apriori algorithm and K-Means in calculating the effect of negative word searches such as porn, sex, gay, and lesbian on the number of divorce hearings in the city of Padang, West Sumatra province. Combining the two methods is called a hybrid system.

**Table 2. Number of Searches for 4 Negative Words in Padang City, West Sumatra Province From August 2018 - July 2020**

No	Month	Porn	Sex	Gay	Lesbian
1	August 2018	310	302	74	217
2	September 2018	177	190	100	189
3	October 2018	124	138	113	103
4	November 2018	128	143	197	180
5	December 2018	172	183	24	110
6	January 2019	123	126	98	81
7	February 2019	85	118	115	113
8	March 2019	129	137	114	151
9	April 2019	113	127	93	111
10	May 2019	108	122	71	135
11	June 2019	188	186	111	92
12	July 2019	117	110	68	74
13	August 2019	93	111	108	130
14	September 2019	111	147	101	112
15	October 2019	89	116	33	64
16	November 2019	86	101	32	72
17	December 2019	122	144	126	116
18	January 2020	90	94	117	54
19	February 2020	95	78	76	83
20	March 2020	102	109	223	89
21	April 2020	72	95	70	53
22	May 2020	112	133	187	159
23	June 2020	70	95	177	58
24	July 2020	63	100	27	37
Sum		2879	3205	2455	2583

The purpose of this research is to reveal how the apriori algorithm calculates the emergence of negative word search data for porn, sex, gay, and lesbians individually or in pairs. Then this study also aims to reveal how the K-Means algorithm can classify negative word searches and divorce trial numbers from a group of existing data. Furthermore, this study also aims to reveal how to combine the apriori algorithm with the K-Means method together (hybrid) in the detection of divorce facts and the behavior of internet users.

## 2. Method

### a. Research Framework

In conducting this research, the authors followed the research framework as presented in Figure 1.

### b. Framework Details

- a. Identification of problems  
Identification of problems is the process of finding out what the main and important problems in the field must be solved in this research.
- b. Study of literature  
Study of literature is the process of seeking or studying sciences and previous research related to solving previously identified problems.

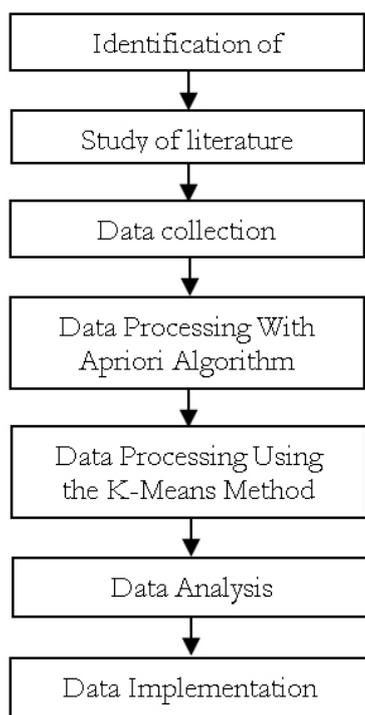


Figure 1. Research Framework

### c. Data Collection

Data collection is the process of collecting field data that will be used in problem-solving. In this study, the data were sourced from the religious courts of Padang City and the google trend page. Data for divorce court figures were taken from the religious court of Padang City from August

2018 to July 2020 and for internet keyword search data, it was obtained from the google trend page for four words, namely the words PORNO (Porn), Sex, HOMO (Gay), and Lesbian from August 2018 to with the month of July 2020. The following data attributes were collected. The data collected attributes can be seen in Table 3.

Table 3. Data Collected Attributes

No	Data Attributes	Data Types
1	Month	Text
2	PORNO (porn)	Text
3	Sex	Integer
4	HOMO (gay)	Integer
5	Lesbian	Integer
6	Divorce Trial Number	Integer

### d. Data Processing With Apriori Algorithm

The data that has been collected in the field is processed using the apriori algorithm. The following are the steps of the apriori algorithm, namely:

- 1) Determine the minimum value of support and confidence value using the formul 1, 2 and 3 [13].

$$\text{Support}(A) = \frac{\text{Number of Transactions Containing } (A)}{\text{Total Transactions}} \quad (1)$$

$$\text{Support}(A \cup B) = \frac{\text{Number of Transactions Containing } (A \cup B)}{\text{Total Transactions}} \quad (2)$$

$$\text{Confidence}(B/A) = \frac{\text{Number of Transactions Containing } (A \cup B)}{\text{Total Transactions } A} \quad (3)$$

Where:

$A$  = Transaction A

$B$  = Transaction B

- 2) Iteration 1: count items from support (transactions that contain all items) by scanning the database for 1-itemset, after 1-itemset is obtained, from 1-itemset is above minimum support if it meets minimum support, 1-itemset it will be a high-frequency pattern [14].
- 3) Iteration 2: to get 2-itemset, 3-itemset, 4-itemset a combination of the previous k-itemset must be done, then scan the database again to count items that contain the support. The itemset that meets the minimum support will be selected as the candidate's high frequent pattern [15].
- 4) Set the k-itemset value of the support that has met the minimum support for the k-itemset.
- 5) So that the item set meets the minimum support and does not meet.
- 6) Carry out the process for the next iteration until no more k-itemset meets minimum support.

### e. Data Processing Using the K-Means Method

The data that has been collected in the field is processed using the K-Means method. The following are the steps for the K-Means method, namely:

- 1) Determine how many clusters will be created which are called values [16]
- 2) Determine the mean (centroid) random value (random) for each predetermined cluster.
- 3) Determine the nearest cluster center on each data record with the centroid value using the formula 4 [17]:

$$d_{\text{Euclidean}}(x, y) = \sqrt{\sum (x_i - y_i)^2} \quad (4)$$

Where:  $d_{\text{Euclidean}}(x, y)$  = the distance value for each record with the centroid value,  $x = x_1, x_2, x_3, \text{etc}$ ,  $y = y_1, y_2, y_3, \text{etc}$ .

- 4) Determine the closest cluster for each data record by comparing the closest distance value that has been obtained previously and then updating the cluster center value (centroid) using the formula 5 [18]:

$$\text{Cluster Center} = \frac{\sum a_i}{n} \quad (5)$$

Where:  $\text{Cluster Center}$  = The cluster center value,  $a_i$  = Value on each cluster,  $n$  = Number of clusters

- 5) Repeating steps 3 to 5 until there is no data transfer from one cluster to another [19] especially in the biomedical domain, where information overload is a major problem. In this paper, we propose a novel biomedical text summarization system that combines two popular data mining techniques: clustering and frequent itemset mining. Biomedical paper is expressed as a set of biomedical concepts using the UMLS metathesaurus. The K-means algorithm is used to cluster similar sentences. Then, the Apriori algorithm is applied to discover the frequent itemsets among the clustered sentences. Finally, the salient sentences from each cluster are selected to build the summary using the discovered frequent itemsets. For the evaluation step, we selected randomly 100 biomedical papers from the BioMed Central database full-text, and we evaluated the performances of our system by comparing the resulting summaries with the abstracts of these papers using the ROUGE metrics in term of recall, precision, and F-measure. We also compared the obtained summaries with those achieved by five well-known summarizers: TextRank, TextTeaser, SweSum, ItemSet Based Summarizer, Microsoft AutoSummarize, and two baselines: summarization using only the frequent itemsets mining (FRQ-CL).

### f. Data Analysis

The data that has been processed and generated using the apriori algorithm and the K-Means method are then

analyzed and conclusions are drawn from the results of the analysis. Data processing for analysis used the Rapid Miner software version 9.7.002 [20].

### g. Data Implementation

The data that has been analyzed and concluded will then be implemented in the field which will later be useful and very helpful for an advisory institution for marriage and other family matters as well as internet managers [21] [22].

## 3. Result

### a. Results of Data Processing Using the Apriori Algorithm

The data collected in the field according to those in Table 1 and 2 are converted into value of 1 and 0, by calculating the average value of each column and comparing each record value with the average value of each column. Table 3 shows the results of converting data in Table 2. The data conversion result from table 2 can be seen in Table 4.

Table 4. Data Conversion Results from Table 2

No	Month	Porn	Sex	Gay	Lesbian
1	August 2018	1	1	0	1
2	September 2018	1	1	0	1
3	October 2018	1	1	1	0
4	November 2018	1	1	1	1
5	December 2018	1	1	0	1
6	January 2019	0	0	0	0
7	February 2019	1	0	1	1
8	March 2019	0	0	1	1
9	April 2019	0	0	0	1
10	May 2019	1	1	0	1
11	June 2019	0	0	1	0
12	July 2019	0	0	0	0
13	August 2019	0	1	1	1
14	September 2019	0	0	0	1
15	October 2019	0	0	0	0
16	November 2019	1	1	1	0
17	December 2019	0	0	1	1
18	January 2020	0	0	0	0
19	February 2020	0	0	1	0
20	March 2020	0	0	0	0
21	April 2020	0	0	0	1
22	May 2020	0	0	1	1
23	June 2020	0	0	1	0
24	July 2020	0	0	0	0

The value of support is calculated using Formula 1 and 2 with the following classification:

- Individual support, namely support A (Porn), support B (Sex), support C (Gay), and support D (Lesbian),
- Support pair 2, namely support A U B (Porn-Sex), A U C (Porn-Gay), support A U D (Porn-Lesbian), support B U C (Sex - Gay), support B U D (Sex-Lesbian), support C U D (Gay-Lesbian)
- Support in pairs 3, namely support A U B U C (Porn-Sex-Gay), support A U B U D (Porn-Sex-Lesbian), support A U C U D (Porn-Gay-Lesbian)
- Support pair 4, namely support A U B U C U D (Porn-Sex-Gay-Lesbian)

Table 5, 6, 7, and 8 show the value of support for 1, 2, 3, and 4 itemset respectively.

**Table 5. Value of Support 1 Itemset**

Aug 2018 – July 2020	Porn	Sex	Gay	Lesbian
1 Itemset	7	7	9	8
Number Transaction	24	24	24	24
Support Value	0.292	0.292	0.375	0.333

**Table 6. Value of Support 2 Itemset**

Aug 2018 – July 2020	Porn - Sex	Porn - Gay	Porn - Lesbian	Sex - Gay	Sex - Lesbian	Gay - Lesbian
2 Item Sets	7	4	5	4	5	4
Number Transaction	24	24	24	24	24	24
Support Value	0.292	0.167	0.208	0.167	0.208	0.167

**Table 7. Value of Support 3 Itemset**

Aug 2018 – July 2020	Porn – Sex – Gay	Porn – Sex – Lesbian	Porn – Gay – Lesbian	Sex – Gay – Lesbian
3 Item Sets	4	5	4	3
Number Transaction	24	24	24	24
Support Value	0.167	0.208	0.167	0.125

**Table 8. Value of Support 4 Itemset**

Aug 2018 – July 2020	Porn – Sex – Gay - Lesbian
4 Item Sets	3
Number Transaction	24
Support Value	0.125

**Table 9. Itemset that meets and do not meet the Minimum Support value**

No	Item Set	August 2018 – July 2020	Support	Qualify /Not Qualify
1	1 Item Sets	Porn	0.292	Qualify
2		Sex	0.292	Qualify
3		Gay	0.375	Qualify
4		Lesbian	0.333	Qualify
5	2 Item Sets	Porn – Sex	0.292	Qualify
6		Porn – Gay	0.167	Not Qualify
7		Porn – Lesbian	0.208	Not Qualify
8		Sex – Gay	0.167	Not Qualify
9		Sex – Lesbian	0.208	Not Qualify
10		Gay – Lesbian	0.167	Not Qualify
11	3 Item Sets	Porn – Sex – Gay	0.167	Not Qualify
12		Porn – Sex – Lesbian	0.208	Not Qualify
13		Porn – Gay – Lesbian	0.167	Not Qualify
14		Sex – Gay – Lesbian	0.125	Not Qualify
15	4 Item Sets	Porn – Sex – Gay – Lesbian	0.125	Not Qualify

Next, calculate the minimum support value. In this study, the minimum support value is 6 or  $\frac{6}{24} = \frac{1}{4} = 0.25\%$ .

By obtaining the minimum support value in Table 8, the next step is to compare the support value for each data line with the minimum support value so that it can be seen which itemset meets and which does not meet. The results of this comparison can be seen in Table 9.

Next, perform data processing using the Rapid Miner application version 9.7.002 and so that the 8 best rules are obtained as presented in Figure 2.

In addition to the 8 best rules in figure 2, the Rapid Miner application also produces an associated rule or Association Rule as in figure 3.

To produce rules as in Figures 2 and 3, the block design built on the Rapid Miner application is as shown in Figure 4.

```

W-Apriori
Apriori
=====
Minimum support: 0.1 (2 instances)
Minimum metric <confidence>: 0.9
Number of cycles performed: 18

Generated sets of large itemsets:

Size of set of large itemsets L(1): 4
Size of set of large itemsets L(2): 6
Size of set of large itemsets L(3): 4
Size of set of large itemsets L(4): 1

Best rules found:

1. SEX=true 7 ==> PORN=true 7    conf: (1)
2. PORN=true 7 ==> SEX=true 7    conf: (1)
3. SEX=true LESBIAN=true 5 ==> PORN=true 5
   conf: (1)
4. PORN=true LESBIAN=true 5 ==> SEX=true 5
   conf: (1)
5. SEX=true GAY=true 4 ==> PORN=true 4    conf: (1)
6. PORN=true GAY=true 4 ==> SEX=true 4    conf: (1)
7. SEX=true GAY=true LESBIAN=true 3 ==> PORN=true
   3    conf: (1)
8. PORN=true GAY=true LESBIAN=true 3 ==> SEX=true
   3    conf: (1)

```

Figure 2. 8 Best Rules Generated

```

AssociationRules
Association Rules
[LESBIAN] --> [GAY] (confidence: 0.500)
[SEX] --> [GAY] (confidence: 0.571)
[PORN] --> [GAY] (confidence: 0.571)
[SEX] --> [GAY, PORN] (confidence: 0.571)
[PORN] --> [GAY, SEX] (confidence: 0.571)
[SEX, PORN] --> [GAY] (confidence: 0.571)
[LESBIAN, SEX] --> [GAY] (confidence: 0.600)
[LESBIAN, PORN] --> [GAY] (confidence: 0.600)
[LESBIAN, SEX] --> [GAY, PORN] (confidence:
0.600)
[LESBIAN, PORN] --> [GAY, SEX] (confidence:
0.600)
[LESBIAN, SEX, PORN] --> [GAY] (confidence:
0.600)
[LESBIAN] --> [SEX] (confidence: 0.625)
[LESBIAN] --> [PORN] (confidence: 0.625)
[LESBIAN] --> [SEX, PORN] (confidence: 0.625)
[SEX] --> [LESBIAN] (confidence: 0.714)
[PORN] --> [LESBIAN] (confidence: 0.714)
[SEX] --> [LESBIAN, PORN] (confidence: 0.714)
[PORN] --> [LESBIAN, SEX] (confidence: 0.714)
[SEX, PORN] --> [LESBIAN] (confidence: 0.714)
[GAY, LESBIAN] --> [SEX] (confidence: 0.750)
[GAY, SEX] --> [LESBIAN] (confidence: 0.750)
[GAY, LESBIAN] --> [PORN] (confidence: 0.750)
[GAY, PORN] --> [LESBIAN] (confidence: 0.750)
[GAY, LESBIAN] --> [SEX, PORN] (confidence:
0.750)
[GAY, SEX] --> [LESBIAN, PORN] (confidence:
0.750)
[GAY, PORN] --> [LESBIAN, SEX] (confidence:
0.750)
[GAY, SEX, PORN] --> [LESBIAN] (confidence:
0.750)
[SEX] --> [PORN] (confidence: 1.000)
[PORN] --> [SEX] (confidence: 1.000)
[GAY, SEX] --> [PORN] (confidence: 1.000)
[GAY, PORN] --> [SEX] (confidence: 1.000)
[LESBIAN, SEX] --> [PORN] (confidence: 1.000)
[LESBIAN, PORN] --> [SEX] (confidence: 1.000)
[GAY, LESBIAN, SEX] --> [PORN] (confidence:
1.000)
[GAY, LESBIAN, PORN] --> [SEX] (confidence: 1.000)

```

Figure 3. Association Rules

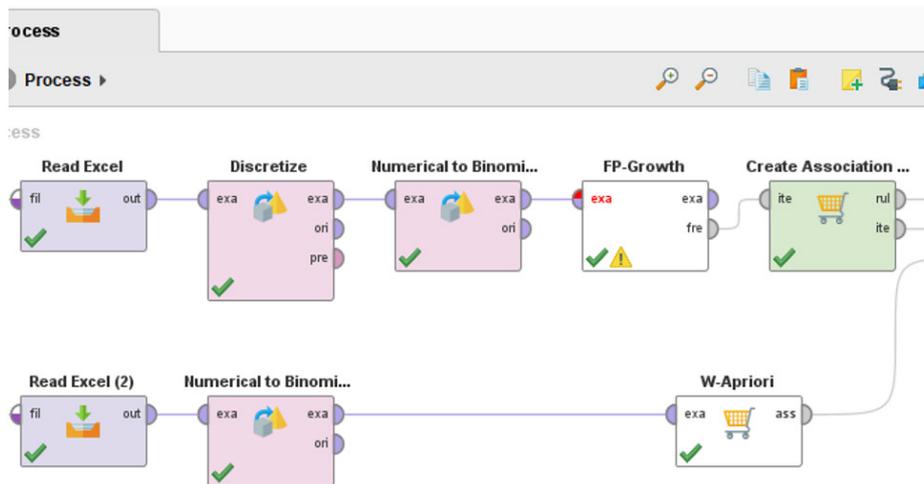


Figure 4. Apriori Algorithm Rapid Miner Block Design

**b. Results of Data Processing Using the K-Means Method**

The data collected in tables 1 and 2 are then grouped (clustered) using the K-Means method.. In this study, 3 clusters were determined for each data attribute. After determining the number of clusters, then determine the middle value (centroid) of each cluster for each attribute. The final scores using the Rapid Miner application can be seen in table 10.

After obtaining the final middle value as in table 10, the results of grouping each row (a record) of data for each attribute are obtained as in table 11.

The results of grouping data as in table 11 are converted into quality values to analyze and calssify them into low, medium, and high values. Table of 12 shows results from the change in numerical values to quality values.

Table 10. Middle Value (centroid)

Atribute	Cluster 0	Cluster 1	Cluster 2
Porn	17.530	27.333	71.0
Sex	73.250	23.503	34.29
Gay	28.214	43.444	7.0
Lesbian	41.429	78.0	28.375
Divorce Trial Numbers	50.833	224.5	133.071

Table 11. Results of Data Grouping

No	Month	Porn	Sex	Gay	Lesbian	Divorce
1	August 2018	cluster_2	cluster_0	cluster_1	cluster_1	cluster_1
2	September 2018	cluster_1	cluster_2	cluster_1	cluster_0	cluster_2
3	October 2018	cluster_1	cluster_2	cluster_0	cluster_0	cluster_2
4	November 2018	cluster_1	cluster_2	cluster_1	cluster_0	cluster_2
5	December 2018	cluster_1	cluster_2	cluster_0	cluster_0	cluster_0
6	January 2019	cluster_1	cluster_1	cluster_1	cluster_2	cluster_1
7	February 2019	cluster_0	cluster_1	cluster_1	cluster_2	cluster_2
8	March 2019	cluster_0	cluster_1	cluster_1	cluster_0	cluster_2
9	April 2019	cluster_0	cluster_1	cluster_0	cluster_0	cluster_2
10	May 2019	cluster_0	cluster_1	cluster_0	cluster_2	cluster_0
11	June 2019	cluster_1	cluster_2	cluster_0	cluster_2	cluster_2
12	July 2019	cluster_0	cluster_1	cluster_0	cluster_2	cluster_1
13	August 2018	cluster_0	cluster_1	cluster_0	cluster_2	cluster_2
14	September 2018	cluster_0	cluster_1	cluster_1	cluster_2	cluster_2
15	October 2018	cluster_0	cluster_1	cluster_0	cluster_2	cluster_2
16	November 2018	cluster_0	cluster_1	cluster_1	cluster_2	cluster_2
17	December 2018	cluster_0	cluster_1	cluster_0	cluster_2	cluster_0
18	January 2019	cluster_0	cluster_1	cluster_1	cluster_2	cluster_1
19	February 2019	cluster_0	cluster_1	cluster_0	cluster_2	cluster_2
20	March 2019	cluster_0	cluster_1	cluster_0	cluster_2	cluster_2

No	Month	Porn	Sex	Gay	Lesbian	Divorce
21	April 2019	cluster_0	cluster_1	cluster_0	cluster_2	cluster_0
22	May 2019	cluster_0	cluster_1	cluster_0	cluster_0	cluster_0
23	June 2019	cluster_0	cluster_1	cluster_0	cluster_2	cluster_1
24	July 2019	cluster_0	cluster_1	cluster_2	cluster_2	cluster_2

Table 12. Results of Changes in Data Value to Numbers

No	Month	Porn	Sex	Gay	Lesbian	Divorce
1	August 2018	Hight	Hight	Hight	Hight	Hight
2	September 2018	Moderate	Moderate	Hight	Moderate	Moderate
3	October 2018	Moderate	Moderate	Moderate	Moderate	Moderate
4	November 2018	Moderate	Moderate	Hight	Moderate	Moderate
5	December 2018	Moderate	Moderate	Moderate	Moderate	Low
6	January 2019	Moderate	Low	Hight	Low	Hight
7	February 2019	Low	Low	Hight	Low	Moderate
8	March 2019	Low	Low	Hight	Moderate	Moderate
9	April 2019	Low	Low	Moderate	Moderate	Moderate
10	May 2019	Low	Low	Moderate	Low	Low
11	June 2019	Moderate	Moderate	Moderate	Low	Moderate
12	July 2019	Low	Low	Moderate	Low	Hight
13	August 2018	Low	Low	Moderate	Low	Moderate
14	September 2018	Low	Low	Hight	Low	Moderate
15	October 2018	Low	Low	Moderate	Low	Moderate
16	November 2018	Low	Low	Hight	Low	Moderate
17	December 2018	Low	Low	Moderate	Low	Low
18	January 2019	Low	Low	Hight	Low	Hight
19	February 2019	Low	Low	Moderate	Low	Moderate
20	March 2019	Low	Low	Moderate	Low	Moderate
21	April 2019	Low	Low	Moderate	Low	Low
22	May 2019	Low	Low	Moderate	Moderate	Low
23	June 2019	Low	Low	Moderate	Low	Hight
24	July 2019	Low	Low	Low	Low	Moderate

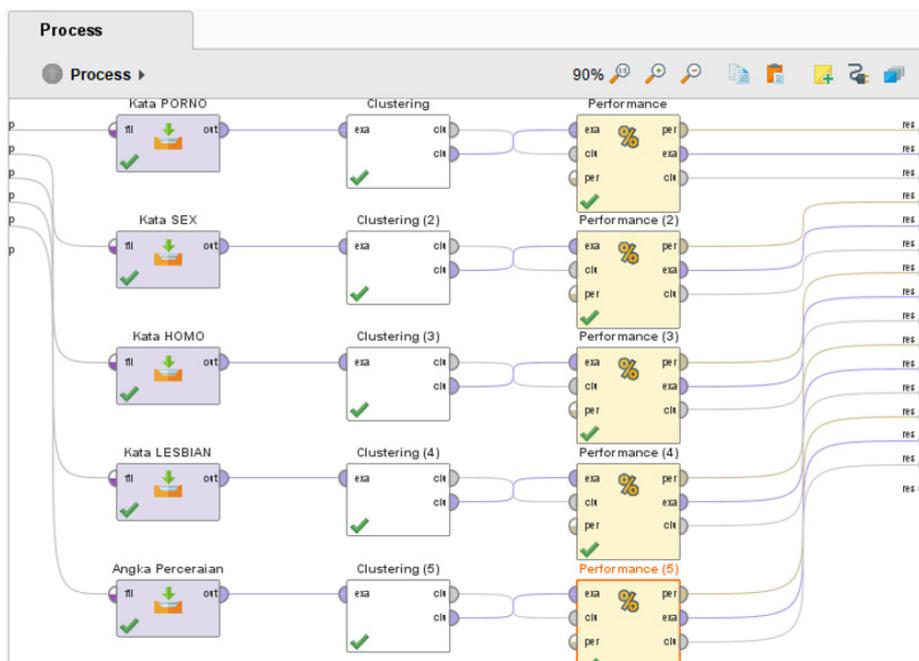


Figure 5. Rapid Miner Block Design of K Means Method

To produce grouping data as in tables 11 and 12 using the Rapid Miner application, a block design is needed, as presented in Figure 5.

#### 4. Discussion

##### a. Discussion of Apriori Algorithm Results

Based on the results of data testing using the Apriori Algorithm method, it can be analyzed that the 8 best rules are found among the 35 existing rules, namely:

1. When someone searches for the word Sex, he/she will simultaneously search for the word Porn with a confidence value of 1
2. When someone searches for the word porn, he/she will simultaneously search for the word sex with a confidence value of 1
3. When someone searches for the word Sex, he/she will simultaneously search for the word Lesbian and Porn with a confidence value of 1
4. When someone searches for the word Porn, he/she will simultaneously search for the word Lesbian and Sex with a confidence value of 1
5. When someone searches for the word Sex, he/she will simultaneously search for the word Gay and Porn with a confidence value of 1
6. When someone searches for the word Porn, he/she will simultaneously search for the word Gay and Sex with a confidence value of 1
7. When someone searches for the word Sex, he/she will simultaneously search for the word Gay, Lesbian, and Porn with a confidence value of 1
8. When someone searches for the word Porn, he/she will simultaneously search for the word Gay, Lesbian, and Sex with a confidence value of 1

##### b. Discussion of the Results of the K-Means Method

Based on the results of data testing with the K-Means method, the word search clustering can be analyzed against the divorce trial figures as follows:

1. The number of divorce hearings is in the High cluster if the search number for the word GAY is also in the High cluster this happened in August 2018, January 2019, and January 2020.
2. The number of divorce hearings is in the Medium cluster if the number of word searches for PORN is in the Medium cluster, the SEX word search number is in the Medium cluster, the GAY word search number is in the Medium cluster, and the LESBIAN word search number is in the Medium cluster. This happened in September 2018, October 2018, and November 2018.
3. The number of divorce hearings is in the Low cluster if the number of word searches for PORN is in the Medium / Low cluster, the number of SEX word searches is in the Medium cluster, the number of word searches for GAY is in the Medium / Low cluster, and the number of word searches for LESBIAN is in the Medium / Low cluster. This

happened in December 2018, May 2019, December 2019, April 2020, and May 2020.

#### 5. Conclusion

This study has successfully combined the apriori algorithm with the K-Means method in detecting divorce facts and the behavior of internet users. The results show that from the 35 rules generated by the apriori algorithm method, the best eight rules show up, meaning that the eight rules have the highest value to describe the true association. The number of divorce hearings is in the cluster High if the search number for the word GAY (gay) is also in the cluster High. The number of divorce hearings is in the cluster Medium if the number of searches for PORN (porn), SEX, GAY, and LESBIAN is all in the cluster Medium. The number of divorce hearings is in the cluster Low if the number of searches for PORN, GAY, and LESBIAN is in the cluster Medium / Low, and the number of searches for SEX is in the cluster Medium.

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# Blind People Stick Tracking using Android Smartphone and GPS Technology

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**Abstract** - Blindness is a term to describe conditions of people who have visual impairments. When a visually impaired do an activity outside, he usually needs a stick to help them move. This study aims to develop a stick tracking that enable a family member to find the location of the blind when they are outside their home and can help the blind to travel. GPS (Global Positioning System) technology allows the stick to get a signal for its location coordinates. When a family member wants to get the location of the blind, he can send a text message with the keyword TRACKER to the mobile phone number of the stick. A GSM (Global System for Mobile Communication) module will send a reply containing the global coordinate, which Google Maps can visualize. In addition, the blind can actively send an emergency help signal to families if they have difficulty finding their way home. An emergency push button is available on the stick, which, if pressed, will send the coordinates to the family's phone number in the form of a short text message. During travelling, blind people can identify obstacles in front of them thanks to an ultrasonic sensor system on the stick. The sensor can detect an object in the range of 100 cm. If the sensor detects an object less than 100 cm, a buzzer will emit an edible sound for the blind. Observations show that the developed stick works well with an average error on the GPS module at a level of 11.89 meters. It also shows a fluctuating percentage of ultrasonic sensor errors depending on the distance of objects.

**Keywords:** android, GPS, smartphone, tracking stick, blind

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## 1. Introduction

Blindness in general is a term used for the condition of people who have visual impairments. For the classification, blindness are divided into two categories: total blindness and low vision [1]. Many factors affects the occurrence of visual disturbances, namely accidents, congenital, and bad habits that can cause a reduction in sight sensory capability. The mobility of blind people to carry out activities is reduced because they have a limited ability of sight. Blind people only depend on the hearing and touch sensory organs [2].

Blind people in carrying out daily activities are usually assisted with several kinds of tools. One tool that is often used is a stick. There are obstacles that blind people get when doing activities outside the house. Often blind

people get lost or have difficulty finding their way home because they are new to the place they are visiting. This incident can cause concern from the family of the parties [3].

The current research gets inspiration from previous researches, which aims at helping families in monitoring the position of the blinds using *GPS Tracker*. An intelligent guide stick has been developed consisting of ultrasound displacement sensors, two DC motors, and a micro-controller [4]. Another paper presents the design and application of an ultrasonic sensor module to detect obstacles, a buzzer to make the blind alert, and a microcontroller 16F877A to provide safe navigation [5]. A group of researchers implement infrared sensors as a range detector and devise a lightweight low power consumption smart stick that can detect obstacle presence

within a range of two meters [6]. Still, another group devises a smart stick that helps guide the user to identify obstacles using various sensors and notify the user as vibrations [7]. Compared to the aforementioned research, the one we propose has a feature to track the user position using a GPS tracker and a GSM module to communicate with someone. A family member, for example, may track the position of the blind by sending a special text message. The blind in an emergency may push a panic button that will send a help alert to the family member which sends the position of the user.

At this time GPS is a tracking system that is used in general. With GPS we can find out the global coordinates of a place [8]. GPS Tracker works by utilizing satellite signals and GSM signals [9]. The tool uses Arduino as an open-source microcontroller. Arduino cannot work alone, so it is necessary to add other supporting components to make it an application that can be used [10]. In the developed tool, Arduino is connected to a GPS module to process Latitude and Longitude data into web addresses that can be connected directly by the Google Maps application. The GSM module sends GPS coordinates that have been converted into a Google Maps link to the mobile number of a blind family via SMS (Short Message Service). In addition, there is a feature so that families can find out the whereabouts of the visually impaired. This tool is equipped with a push-button that is useful for blind people to send a location signal to the family's smartphone when an emergency occurs in the middle of the trip. In addition to the GPS component, the blind person's walking stick is equipped with an ultrasonic sensor that functions to detect obstacles that are in front of the blind person. If there is an obstacle in front of the blind person, the buzzer will make a sound that can be heard by the blind person.

## 2. Method

### a. System design

The stages of designing a tracking stick based on an android smartphone and GPS technology are described in Figure 1. The design of this tool requires several components such as Arduino Nano, ublox Neo 6mV2 GPS module, GSM Sim800L module, ultrasonic sensor HC-SR04, Buzzer, DC-DC step-down LM2596, and push-buttons. Each component has its function. Arduino Nano is the microcontroller that is the brain for this device. The ublox Neo 6mV2 GPS module functions to determine the coordination point in the form of latitude and longitude data. On SIM 800L there is a receiver leg that functions as a sender and a transceiver leg as a receiver [11]. However, for SIM 800L to work properly, the voltage from the Arduino needs to be lowered to 4.4 V using the LM 2596 DC-DC Step-down component [12]. The ultrasonic sensor HC-SR04 serves to detect obstacles that are in front. The sensor works by utilizing ultrasonic waves reflected by obstacles in front and converted into distance [13].

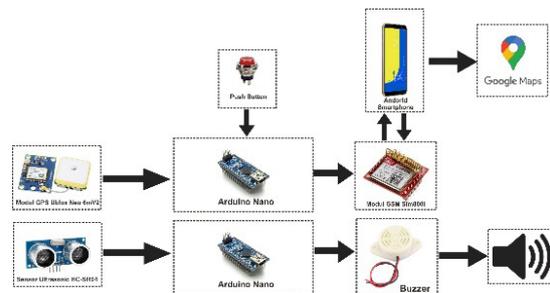


Figure 1. System Block Diagram

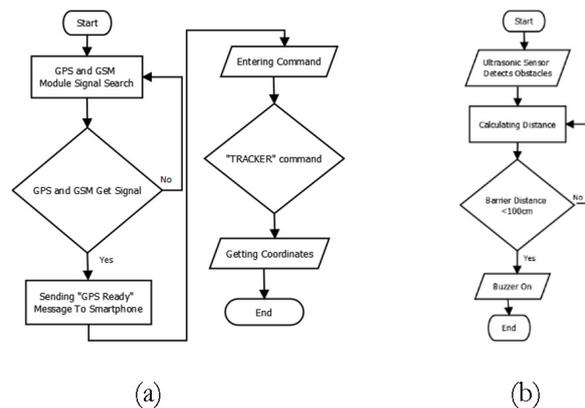


Figure 2. (a) Flowchart on tracking system; (b) Flowchart on ultrasonic system

Figure 2 shows the system workflow on the tracking stick. The tracking stick works with two systems, namely a GPS tracking system to determine the coordinates of the stick and an ultrasonic system to detect obstacles in front of blind people. The way the GPS tracking system works is to look for signals on the GPS module and GSM module. After the GPS module and GSM module get a signal, the stick has got the coordinates through the GPS module which can be sent to the smartphone via the GSM module. The next system is the ultrasonic system. The way the ultrasonic system works is to detect obstacles in front of blind people with a predetermined distance of 100 cm. If the ultrasonic sensor detects an obstacle in front with a distance of less than 100 cm, the buzzer will sound.

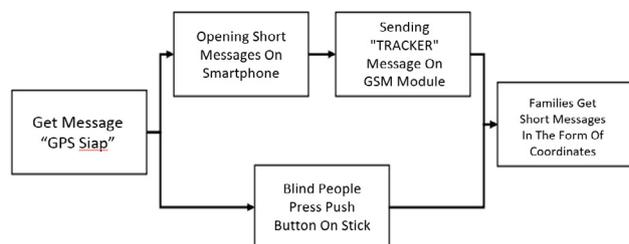


Figure 3. Block diagrams get coordinates using a smartphone and a push-button

Figure 3 describes how the coordinate point delivery system is via a smartphone and a push button. The sending of coordinates of the GPS module on the stick is sent by

the GSM module to a smartphone that can be accessed by families with visual impairments. Requests for the coordinates of the GPS module using a smartphone can be done by sending an SMS with the keyword "TRACKER" through a short message application on the smartphone and sent to the GSM module. Short messages with these keywords will get a reply in the form of coordinates that have been converted into links so that they can be displayed via the Google Maps application. Sending coordinates can also be done using a push button. How to send coordinates, by pressing the push button on the blind stick. After that, the coordinates will be sent by the GSM module via a short message on the smartphone.

### b. Electronic Design

The electronic circuit schematic in this tool is designed using Eagle as software for making PCB layouts and Fritzing as software for making wiring diagrams. Figure 4 is a diagram used to create a PCB layout using Eagle.

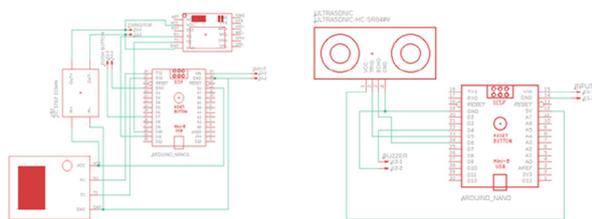


Figure 4. (a) Schematic of the GPS module; (b) ultrasonic module schematic

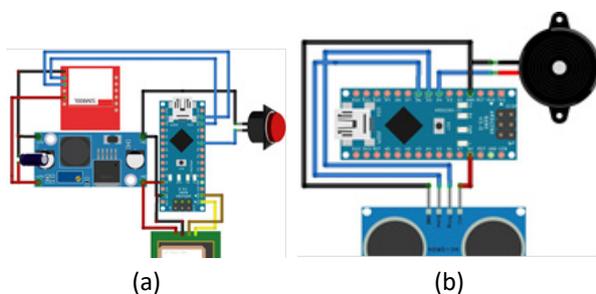


Figure 5. (a) GPS module wiring diagram; (b) Ultrasonic module wiring diagram

The wiring diagram created using the Fritzing software will be shown in Figure 5. The wiring diagram for the GPS is shown in Figure 5a and the wiring diagram for the ultrasonic system is shown in Figure 5b. The GPS module requires a voltage of 5 volts and the RX TX pin is connected to the Arduino Nano's RX TX pin. The GSM module requires a voltage of 4 volts so it requires a DC stepdown to lower the 5-volt voltage from the Arduino. The TX pin of the GSM module is connected to pin 10 of the Arduino Nano and the RX pin is connected to pin 11. The push-button is connected to pin 7 of the Arduino Nano. The wiring diagram in Figure 5b is for the ultrasonic circuit. The ultrasonic circuit requires a voltage of 5 volts

on the Arduino Nano. The trigger leg on the ultrasonic sensor is connected to pin 5 of the Arduino Nano and the Echo leg is connected to pin 6. The buzzer is connected to pin 4 of the Arduino Nano.

### c. Hardware Design

Figure 6 shows the hardware design of a tracking stick for blind people based on Android smartphones and GPS technology. The design for this tracking stick is kept as minimal as possible which aims for the comfort of the visually impaired when using it. The voltage source in the stick tracking system is obtained from two 9 volt batteries. Each system on this tracking stick is supplied by each 9-volt battery which aims so that when the tool is used, the power in the battery does not run out quickly and lasts a long time. In Figure 6, component 1 is a push button, component 2 is an electronic component box, component 3 is a 9-volt battery, component 4 is a stick, and component 5 is an ultrasonic sensor.

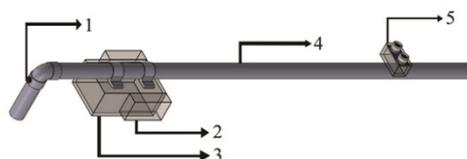


Figure 6. Tracking stick hardware design; see the text for the meaning of the numbers in the pictures

## 3. Result

### a. Results of the Design of the Tracking Stick

The making of this tracking stick hardware uses a 2.5 cm diameter pipe with a stick length of 80 cm and a handle length of 7 cm. While the component box on this stick is made of acrylic material with dimensions of 11.8 cm long, 7.5 cm wide, and 5 cm high. The box for components is made as minimal as possible so as not to affect the weight of the cane too much which affects the comfort of the visually impaired when using a cane. The weight of this stick is 0.73 kg.



Figure 7. Blind stick hardware

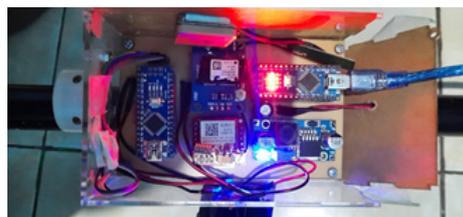


Figure 8. The electronic circuit inbox



2) GSM Module Testing

GSM module testing aims to determine the effectiveness of the GSM module. The GSM module has an LED as an indicator. If the LED flashes every 1 second, then the module is looking for a signal. If the LED flashes every 3 seconds, then the GSM module has received a signal [16]. The GSM module test uses two types of hardware, namely the Samsung A50s smartphone that is connected to the Telkomsel provider and the second uses a push button that can be accessed by the visually impaired. To determine the location of the stick using a smartphone, the user needs to send an SMS with the keyword "TRACKER". SMS is sent to the SIM800L module which will reply with the location of the stick. To test the work of the push button, the user only needs to press the push button on the stick. This action will cause the GSM module to send the coordinates of the stick to the smartphone.

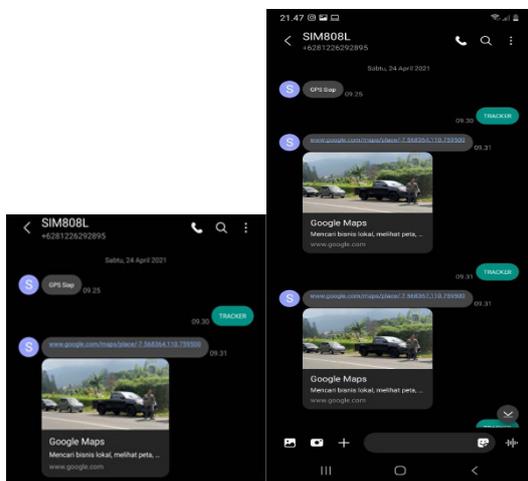


Figure 10. (a) The GPS is on; (b) send keywords to get location

Table 2. GSM module testing with smartphones and push buttons

Trial to-	Response Time(s)	
	Device Smartphone	Device Push Button
1	11.12	7.8
2	11.22	8.2
3	14.23	7.6
4	10.5	7.7
5	10.66	11.8
6	11.21	8.9
7	12.17	6.6
8	10.77	8.9
9	10.9	7.4
10	9.97	7.2
<b>Average</b>	<b>11.27</b>	<b>8.21</b>

Table 2 shows the GSM module test data that gives different response times to two different actions. Tests

using smartphone devices show the longest response time is 14.23 seconds and the fastest response time is 9.97 seconds with an average overall response time of 11.27 seconds. Testing the GSM module using pushbuttons produces the longest response of 11.8 and the fastest response of 6.6 seconds with an average response time of 8.21 seconds. Tests show that the smartphone device takes longer to get the stick location data if the data is retrieved using SMS from the smartphone.

3) Ultrasonic Sensor Test

Testing of the ultrasonic sensor HC-SR04 was carried out to find out the accuracy of the ultrasonic sensor HC-SR04 in determining the distance [17]. The distance that can be read by the ultrasonic sensor is 2–500 cm [18]. Determining the accuracy of the sensor requires a comparison measuring instrument, namely a ruler. The object used in determining the distance is a solid object with a flat surface to obtain consistent measurement results [19].

Table 3. Ultrasonic Sensor Testing HC-SR04

No.	Set Distance (cm)	Sensor Reading (cm)	Difference (cm)	Error
1	10	10.44	0.44	4%
2	20	19.5	0.5	3%
3	30	29,15	0.85	3%
4	40	39.95	0.05	0%
5	50	48.11	1.89	4%
6	60	57.41	2.59	4%
7	70	67.44	2.56	4%
8	80	76.82	3.18	4%
9	90	87.45	2.55	3%
10	100	97.29	2.71	3%
Rata-rata			1.732	3%

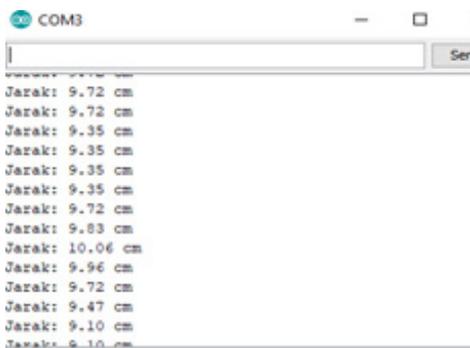


Figure 11. Ultrasonic sensor reading a serial monitor

Table 3 shows the test data for the ultrasonic sensor HC-HS04 with a distance range of 10 – 100 cm. In measurements with a set distance of 10 cm, the sensor readings show an error of 0.44 cm. The error will continue to increase as the test distance increases. The test shows that the farther away the object is, the greater the

difference in distance between the comparison measuring instrument and the sensor. Figure 10 shows a serial monitor for ultrasonic sensor readings. The calculation of the percentage error using equation 3, where x is the ultrasonic sensor distance reading (cm) and y is the distance on the comparison measuring instrument (cm).

$$\text{Error} = \frac{x - y}{y} \times 100\% \quad (3)$$

**Table 4. Ultrasonic sensor testing with three obstacle**

Set Distance (cm)	Obstacle			Error		
	Wall (cm)	Tree (cm)	Human (cm)	Wall	Tree	Human
10	9.96	9.96	10.73	0%	0%	7%
20	18.79	18.56	19.8	6%	7%	1%
30	29.37	29.94	29.63	2%	0%	1%
40	38.77	39.15	38.56	3%	2%	4%
50	48.45	48.28	47.83	3%	3%	4%
60	58.34	57.7	58.65	3%	4%	2%
70	68.63	68.78	68.12	2%	2%	3%
80	78.22	78.98	76.33	2%	1%	5%
90	87.77	82.28	85.94	2%	9%	5%
100	97.11	96.97	97.73	3%	3%	2%

Table 4 shows the results of ultrasonic sensor testing using three different obstacles, namely walls with a thickness of 14.5 cm, trees with a thickness of 36 cm, and humans. The reason for choosing the three obstacles is because when the visually impaired travel, the three obstacles are the most frequent. The ultrasonic sensor test data shows a fluctuating value. This is because, in each set of distances, the sensor readings have a percentage error that results up and down. The error calculation in this test is carried out using equation 3.

#### 4. Discussion

Smart sticks have been designed and tested a lot. Most of the tools designed are focused on obstacle detection that helps blind people when moving. Sensors used can be ultrasonic or infrared sensors. Meanwhile, the indication of an obstacle is manifested in the form of a buzzer or vibration. Not many tools are equipped with GPS and GSM modules that help monitor the position of blind people or help people with disabilities during emergencies. A blind stick with a GPS tracker feature like this provides an additional function to find out the location of the blind person that can be accessed via a smartphone. In addition, blind people can also press the push button on the blind stick to send a signal of help to the family. This is very helpful for blind people and families of blind people.

#### 5. Conclusion

The constructed tracking stick can help blind people detect obstacles in the front, which help them move

around during travelling outside. The tool can help family members find locations of the blind by replying to a specified text message with the coordinates. It also assists blind people to send an emergency message containing their position by pressing a push-button if they forget their way home. The average coordinate position error is 11.89 meters. The percentage error of the ultrasonic sensor fluctuates depending on the distance and type of object in front of the stick.

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# Application of the UTAUT Model for Acceptance Analysis of COBIT Implementation in E-Learning Management with Microsoft Teams on Distance Learning in Batam City

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**Abstract** - Since March 2020, due to the COVID-19 pandemic and in line with Merdeka Belajar - Kampus Merdeka, higher education institutions have conducted distance learning in asynchronous and synchronous modes, such as video meetings using Microsoft Teams and provide e-learning. In order to reach the goals and strategies of the higher education institutions, universities implement several control objectives within the COBIT 5 framework, so they can use and manage resources efficiently, provide the best education for students. This study aims to analyze the acceptance level of the COBIT implementation in higher education institutions by using the UTAUT model in E-Learning management, the use of Microsoft Teams and distance learning. This study uses a quantitative approach with a causal explanatory research design. Dissemination of the survey was conducted by simple random sampling at 6 (six) universities in Batam City. This study reveals that E-Learning management, the use of Microsoft Teams, and the application of distance learning together have a significant influence on the implementation of COBIT with an acceptance index of 85.5%, which refers to the satisfying category.

**Keywords:** COBIT, Distance Learning, E-Learning, Microsoft Teams

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## 1. Introduction

The city of Batam is located in the province of the Riau Islands, with the largest population among other cities/regencies, and Batam is known as a miniature of Indonesia because almost all ethnic groups in Indonesia can be found in Batam City. In line with Batam's population growth, the growth in the number of students and educators in Batam City has also increased, recorded in 2019 as many as 30,407 students, and in 2020 as many as 32,195 students with total teaching staff in 2019 of 1299 people to 1451 people in 2020. spread over 24 universities [1].

In accordance with Press Release Number: 055/SIPRES/A6/III/2020 issued by the Ministry of Education and Culture on March 16, 2020, during the COVID-19 pandemic, in Indonesia to temporarily stop academic activities such as face-to-face lectures, and each university to immediately take a policy regarding the learning process from home for students. Learning that is usually done face-to-face is then replaced with distance learning. The

distance learning system is used to suppress the spread of COVID-19 so as not to infect more people [2]. Thus in Batam City, with the issuance of Circular Number 133/419.1/DISDIK/III/2020 concerning Anticipation of Prevention of the Spread of Corona Virus Disease (COVID-19) in Batam City, several universities in Batam City implemented online learning even until the year 2021. However, there were three sub-districts in Batam City declared as green zones and three sub-districts yellow zones on February 11, 2021. Universities still enforce online learning because three sub-districts were quite densely populated, were still red zones; Batam City, Sekupang and Lubuk Baja.

Online learning is also known as e-learning (electronic learning) or online learning (on a network), and this learning uses a number of platforms such as websites, applications, social media, and LMS (Learning Management System) [3]. The use of this LMS is considered effective in managing online learning because the features available are quite complete and can be accessed by lecturers and

students [4]. As for the use of video conferencing, learning video and chat are information technology-based distance learning concepts [5], and applications that support such as Microsoft Teams, Google Meet, Zoom. The use of e-learning can provide various benefits for teaching, and in terms of using technology and pedagogy to improve the learning process in order to achieve learning objectives, it is also easy for students to obtain learning information that is followed so that students are more interested and active in learning [6].

Distance Learning is a teaching and learning process carried out by two parties, the first party is the teacher or lecturer as a teacher, and the second party is the student or student as a learner who is carried out without meeting face to face, but using the media, due to the position of both parties who are in different positions, even separated by great distances. Distance learning is referred to as distance education, where the lecturer as an instructor gathers with participants or students at different places and even at different times, and the instructor provides detailed materials and instructions for students, then the instructor evaluates the assignments given to his students [7]. Distance learning is also known as online or virtual learning because it uses internet media that helps lecturers and students interact online [2]. The learning process is accessed through internet technology, and learning materials are provided in the form of multimedia content, videos, and texts [8]. It provides access to learning content that makes use of all media attributes [9]. This online learning is in accordance with the Industrial Revolution 4.0, which puts forward IoT or the internet as the spearhead in all aspects [10]. The purpose of online learning is to provide quality, massive and open learning services so that it can reach more and wider learners [11], and other researchers [12] said that many students who already had this level of satisfaction with online learning were more motivated to take classes and made a strong effort to achieve success. Distance learning is held by utilizing technology in the form of virtual applications [4]. In distance learning, it is necessary to pay attention to the competencies to be taught, where the teacher needs to pay attention to the pedagogical, psychological and didactic aspects in addition to providing material and assignments. Therefore, it is necessary to plan, implement and evaluate as well as face-to-face lectures [13].

E-learning is an online lecture by sending learning materials without being limited by time and place using technology in an open, flexible, and distributed learning environment [14]. E-Learning is distance learning using the help of information and communication technology, and has two perceptions: the first is based on electronic devices such as LCD, film, video; and the second perception is internet-based learning, learning that uses the internet as the main media so that students can access learning materials without being limited by place and time [15]. Changes or paradigm shifts in learning systems began to appear in the process of knowledge transfer. The current learning process tends to focus more on the

teaching process, based on content, abstract and only for certain groups (in the passive teaching process). Along with the development of science and technology in ICT in the learning process began to shift in the learning process (*learning*), based on the problem (*case-base*), is contextual in nature and is not limited to certain groups. In this learning process, students are required to be more active by optimizing existing learning resources, especially through the internet [16].

E-learning integrates the main components of e-learning, such as Learning Management Systems (LMS), content management systems, and learning content management systems. Learning Management System is a web-based software application designed to manage learning materials, student-teacher interactions, assessment tools and reports on learning progress and student activities. Online learning content is accessed through the LMS, which allows students to view and interact with learning tools through a web browser using any operating system, computer or mobile device. LMS can be categorized into three types, namely (1) as a learning tool & activity through quizzes, presentations and assignments; (2) communication tools between teachers and students such as discussions, *chat*, and announcements; (3) tools to increase productivity in learning through document management systems, calendars, surveys, teachers can find out how often students access the LMS, and students can find out the evaluation of grades given by teachers [17] meskipun mayoritas mahasiswa (95,8%).

According to [18], the implementation of e-Learning has factors that lead to the efficiency and effectiveness of e-learning, namely: characteristics of instructors and students, quality of information technology, support from management or organizers of educational institutions, participant interaction and quality of learning materials. This support from the management has 4 (four) elements, namely: (1) market research by analyzing learning methods according to user needs; (2) a teaching framework by determining policies and procedures that are in accordance with the needs of all parties for the progress of students and educators; (3) operational planning by improving and improving all academic activities so that the e-learning learning process becomes more leverage; (4) cost-effectiveness in which management will carry out cost control and implementation.

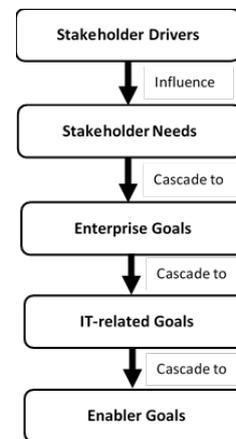
In this Industrial Era 4.0, the development of information and communication technology has provided many benefits in the field of education. This can be seen in the increasingly easy access for teachers and students so that the online learning process can take place using learning application platforms and LMS in online learning. A popular online learning platform is Microsoft Teams which is an application in Microsoft Office 365 or often called Teams [19]. The Microsoft Teams feature supports interaction and collaboration between teachers (lecturers) and students (students) in an online network using the internet and is very suitable for use during the pandemic. The chat room feature allows teachers to have

discussions with students via chat, and online rooms are used by teachers face-to-face. With students online, so that teachers can evaluate and directly monitor learning activities with students [5].

Microsoft Teams also provides additional features for teachers and students to use, such as creating polls to ask students, building a database that houses a collection of frequently asked questions by teachers, and communicating with students privately. Microsoft Teams can be used for group work, and students respond positively to its ease of use, and even students are enthusiastic about using Microsoft Teams in the future if asked. This shows that new skills have been developed, a positive thing that continues to increase in digital literacy in graduates. Microsoft Teams can create any number of groups, and these groups also take advantage of document collaboration features and video conferencing tools [20]. Microsoft Team has several versions, namely a web version, a desktop version and a mobile phone version. Students who are just learning to use the Microsoft Teams application are advised to use the web version. Then for students who are going to do online learning, it is recommended to use the desktop version because it is easier to use. The mobile version of Microsoft Teams can be used by students who have high mobility who require them to continue to follow online learning at any location as long as they are connected to the internet [19].

According to [21], in order to implement the e-learning system in universities, it must be arranged to ensure that the operation of the e-learning system is in line with the goals and strategies of the institution, uses and manages resources efficiently, provides the expected value from the organization, manages its risks, and its performance can be measured. Based on the ISACA survey shows that many companies still have not succeeded in showing the expected value from the company that is concrete and measurable from the investments that have been issued to support the implementation of information technology (IT). Therefore IT Governance is needed as a mechanism to overcome this situation [22]. IT Governance is defined as a framework that supports the management of all information resources (human resources, costs, and infrastructure) to achieve organizational goals effectively and efficiently. This IT Governance aims at how IT can provide sufficient value to the business and how the risks that exist and arise from the existence of IT can be managed. IT Governance can use the COBIT framework and be modified according to the needs of the local context of each institution [23], and the e-learning system must accommodate various interests such as government regulations, institutional goals and strategies, and the needs of lecturers and students which include: the availability of services, completeness of features and functions, as well as considerations of IT literacy from lecturers and students [24]. In COBIT 5 Cascading, as shown in Figure 1, that stakeholder drivers influence stakeholder needs, and it will cascade to enterprise goals, then cascades to IT-related Goals and finally cascades to Enabler Goals. [24]. COBIT

5 IT-related Goals has four dimensions of the Balanced Scorecard, namely: Financial, Customer, Internal, and Learning and Growth. There are 17 kinds of IT-related Goals, of which the Financial dimension has 6 (six) IT-related Goals, the Customer dimension has 2 (two) IT-related Goals, the Internal dimension has 7 (seven) IT-related Goals, and the Learning and Growth dimension has 2 (two) IT-related Goals [25].



**Figure 1. COBIT 5 Cascading**  
Source: COBIT 5 Framework

The UTAUT model was formulated by [26] as a combined model or theory of acceptance and use of technology using four direct determinants, namely: performance expectancy, effort expectancy, social influence, and facilitating conditions. Performance expectancy is defined as the level of individual belief in the use of technology in supporting individual performance to make work better and easier [27]. Effort expectancy is defined as the level of ease in using an information system; the easier it is to use, it will create a feeling of comfort and feel that the system used brings benefits [28]. Social influence is defined as the level of environmental influence on users to use information systems or new information technology [27]. When the user is going to use something new, it is necessary to get support from others, and the influence of this other person becomes a significant factor [28]. Facilitating conditions, facilitating conditions is the level of individual trust in the infrastructure and supporting facilities owned by an organization to support the use of information systems or information technology [27].

The implementation of e-learning in higher education must be regulated to ensure that the implementation of e-learning is in line with the goals and strategies of the higher education institution, uses and manages resources efficiently, provides the expected organizational value, manages its risks, and its performance can be measured. Information technology resources can be an enabler for various efforts to improve quality, effectiveness, efficiency, and accountability in higher education [29]. Therefore, universities need to have good Governance through the implementation of the COBIT 5 framework for e-learning governance and management from the aspects of policies,

learning processes, organizational structures, organizational culture, information, infrastructure & applications, human resources [24]. This strategic plan of information systems and information technology governance supports the direction and management of IS / IT in universities [30]. The use of Microsoft Teams as a learning medium in universities is quite popular [19]. The implementation of Good Governance provides benefits for students who are running distance learning using e-learning with Microsoft Teams learning media. Therefore, this research is to analyze the acceptance of COBIT implementation in e-learning management with Microsoft Teams in distance learning in Batam City, and this study uses the Unified Theory Of Acceptance and Use Of Technology (UTAUT) as a model to understand the extent to which student acceptance of the implementation COBIT includes Governance and management implemented by universities to support the learning process for students and based on the mapping of COBIT 5 IT-related Goals, this study focused on Customer dimension which has two goals: (1) delivery of IT services in line with business requirements; and (2) adequate use of applications, information and technology solutions [25].

## 2. Method

### a. Analysis Techniques

The research carried out is in the form of a quantitative approach that is carried out to see the results of distance learning. The research period is held for four months, starting from February 2021 to May 2021. The research location is carried out at universities in Batam City. Quantitative research is based on a population of 20,803 university students in Batam City, and universities have an e-learning system and conduct distance learning.

The number of questionnaires to be sent will be calculated based on a sampling formula for a population of 103 students in Batam City, with an expected response rate of 100% or a full return. Sample size uses the Slovin formula with the following calculations:

$$n = N / ((N \times d^2) + 1) \quad (1)$$

where  $n$  is the sample,  $N$  = population,  $d$  = margin of error, so the following calculation is obtained:

$$n = 20.803 / ((20,803 \times 10\%^2) + 1) = 102.5 = 103$$

The number of samples used in this study was a minimum of 103 students at universities in Batam City.

### b. Data Collection Method

The data collection method in this study used convenience sampling. Every student of online learning and distance learning programs can be a sample, as long as the College organizes eLearning. Questionnaires were collected through electronic questionnaires (e-questionnaires), which were distributed via Google forms, links to questionnaires were distributed in online learning forums, mobile applications, and e-mails. The questionnaire uses a Likert scale from a scale of 1 to 5. A scale of 1 strongly disagrees, and a scale of 5 strongly agrees [31].

Before the survey was distributed to all respondents, the researcher carried out preliminary research by distributing 30 questionnaires to carry out validity and reliability tests [31]. After the distribution of the preliminary research was carried out, 103 samples were taken, of which six universities were the respondents in Table 1.

**Table 1. Universities in Batam that Have E-Learning Systems use Microsoft Teams and Implement Distance Learning**

Name	Web	Call	E-mail	E-learning website	Number of Students
Batam International University (UIB)	www.uib.ac.id	0778-6002999,7437111	info@uib.ac.id	https://elearning.uib.ac.id/	4,621
Batam Institute of Technology (ITEBA)	www.iteba.ac.id	0778 – 3540889	info@btp.ac.id		2,822
Batam University (UNIBA)	www.univbatam.ac.id	0778-7485055	info@univbatam.ac.id	https://elearning.univbatam.ac.id/	2,914
Riau Archipelago University (UNRIKA)	www.unrika.ac.id	0778-392752	info@unrika.ac.id	https://www.unrika.ac.id/e-learning/	7,456
Universal University (UVERS)	www.uvers.ac.id	(0778)473399, 466869	info@uvers.ac.id	http://elearning.uvers.ac.id/	890
Batam Polytechnic (POLTEK BATAM)	www.polibatam.ac.id	0778-469858	info@polibatam.ac.id	https://learning.polibatam.ac.id/	2,100
<b>Total</b>					<b>20,803</b>

### c. Research Variable

According to [32], a variable is a form that can be determined to be studied so as to get the information you want to know. This definition was investigated to find out whether E-Learning Management, Use of MS-Teams and Distance Learning as an independent variable has an effect on Acceptance of COBIT Implementation as the dependent variable. Based on the conceptual of the research that has been stated previously, the variables of this study are divided into the following:

#### a. Independent Variable

According to [32] Independent Variables, namely variables that are not predicted by other variables in the model. Independent variables are also known as independent variables. In this study, the independent variables are E-Learning Management (X1), Use of MS-Teams (X2), Distance Learning (X3).

#### b. Dependent Variable

According to [32], Dependent Variables is variables that are predicted by one or more other variables in the model. The dependent variable is also known as a dependent variable. In this study, the dependent Variable (bound) is the Acceptance of COBIT Implementation.

### d. Research Model

The research model in Figure 2 consisted of three independent variables, namely E-Learning Management, Use of Microsoft Teams, Distance Learning, and one dependent Variable, namely The Acceptance of COBIT Implementation. Based on the research model, indicators and statements for each Variable were constructed in order to measure the index of students' acceptance of COBIT Implementation by using the UTAUT model.

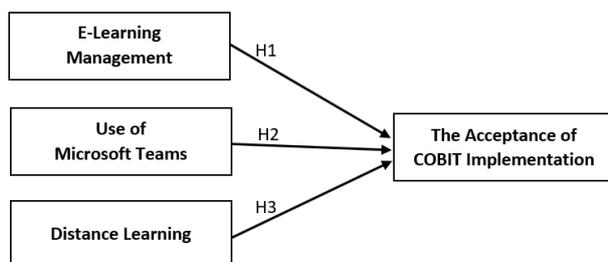


Figure 2. Research Framework  
Source: Researcher Process, 2021

### e. Hypothesis Development

As seen in Figure 2, the researcher hypothesized that firstly by maintaining e-learning management well, secondly by providing use of Microsoft Teams as an online meeting tool, thirdly by conducting distance learning; these would foster students' acceptance of COBIT Implementation which are conducted by 6 (six) higher education institution as listed in Table 1. The first hypothesis indicates how higher education institution delivers e-learning as IT services in line with the requirement and make sure students can use e-learning as a learning medium, communication and productivity

media [17]. The second hypothesis indicates how higher education institution provides Microsoft Teams as an online meeting tool that can meet student requirement and adequately supports student interaction with lecturers [5]. The third hypothesis indicates how higher education institution conducts distance learning within COVID-19 pandemic situation in order to keep delivering education services by using information technology, and students can get the benefit of distance learning such as using virtual application technology, flexibility in learning (anywhere and anytime), and well-provided learning material [13]. Acceptance of COBIT Implementation is adopted from the UTAUT model and measured by four indicators: performance expectations, business expectations, social influences, and facilitating conditions [26].

The hypotheses in this study, as described in Figure 2, are structured as follows:

H1: E-Learning Management has a significant effect on the Acceptance of COBIT Implementation.

H2: Use of Microsoft Teams has a significant effect on the Acceptance of COBIT implementation.

H3: Distance Learning has a significant effect on the Acceptance of COBIT Implementation.

## 3. Results

This study uses data collection techniques by distributing questionnaires through direct distribution to university students in Batam City with the assistance of lecturers who teach classes at each existing university. Respondents were appointed randomly in each class and by using the consideration that they were active students in the College so that these students were valid respondents because they could feel the perception of acceptance of COBIT implementation in the use of e-learning and Microsoft Teams in distance learning in College.

### a. Research Data

The distributed questionnaires began to be distributed to UIB, UNIBA, UNRIKA, UVERS, ITEBA and POLTEK BATAM. The total number of questionnaires that have been collected is 116, which are suitable for use, and 11 are not suitable for use (not filled out completely). In accordance with the desired sample size, 103 questionnaires were used, so that a total of 11 questionnaires were not used as research data. The questionnaires used in this study were 103 pieces.

### b. Respondent Profile

Based on the data processing that has been carried out, the profiles of respondents who have filled out research questionnaires that have been distributed show the categories of research respondents in terms of gender; This profile data shows that there are 49 people or 47.6% of respondents who are male and 54 people or 52.4% are female. This result has represented the academic community and is in accordance with the representation of the academic community in Batam City, which is in

accordance with the population (Ministry of Research, 2020).

The next data from the respondent profile of this research is related to the origin of the respondent's university. It can be seen that the respondents come from 6 universities in Batam City, which already have E-Learning Management for their learning process; namely three people or 2.9% came from the ITEBA; 8 people or 7.8% came from POLTEK BATAM; 1 person or 1.0% comes from the UNIBA; 41 people or 39.8% came from UIB; 43 people or 41.7% came from the UNRIKA, and seven people or 6.8% came from UVERS. Based on these data, it can be concluded that respondents already have a representative proportion of all respondents who come from universities in Batam City that have e-learning management, use Microsoft Teams and conduct distance learning currently. They apply information technology governance in order to support the learning & teaching process in pandemic situations.

Descriptive analysis was carried out to show an overview of the research variables (E-Learning Management, Use of Microsoft Teams, Distance Learning, Acceptance of COBIT Implementation) used in this study.

#### c. Description of E-Learning Management Variable

E-Learning Management variable is explained into 10 (ten) instruments which are grouped into 3 (three) indicators that explain e-learning management as a learning medium, communication media and media to increase student productivity [17]. The first indicator, E-learning as a learning medium, is described in 5 (five) instruments which confirm that students can understand learning outcomes, materials & assignments, evaluations. The second indicator, E-Learning as a communication medium, is described in 2 (two) instruments that confirm student interactions with lecturers, fellow students and universities. The third indicator, E-Learning as a tool to increase learning productivity, is described in 3 (three) instruments which emphasize that students can study more productively. Based on the data, it can be explained that "E-Learning Management" has a high perception of holding on to the opinions of respondents with an average value of 3.47; this value is in the high category. The X1.8 instrument has the highest value, which is 3.62. According to the respondent, "I find it easy to upload and download files such as lecture materials, assignments, quizzes in E-Learning". On the other hand, the X1.3 instrument has the lowest score, which is 3.34 according to the respondent's opinion is "Lecture material is given through Lecturer presentation videos uploaded to E-Learning or in the form of Youtube links".

#### d. Description of Use of Microsoft Teams Variable

The use of Microsoft Teams variable is explained into 10 (ten) instruments which are grouped into 3 (three) indicators which explain that Microsoft Teams supports student interaction with lecturers, written discussion (chat), and online, face-to-face evaluation [5]. The first indicator,

the use of Microsoft Teams to support interaction between students and lecturers, is described in 4 (four) instruments. The second indicator, Microsoft Teams supports written discussion, is described in 3 (three) instruments. The third indicator, Microsoft Teams, supports the online, face-to-face evaluation process, is described in 3 (three) instruments. Based on these data, it can be explained that "Using Microsoft Teams" has a high perception of holding on to the opinions of respondents with an average value of 3.42; this value is in the high category. The X2.1 instrument has the highest score of 3.63 according to the respondent is "Microsoft Teams can be used as a medium for presenting material". On the other hand, the X2.8 instrument has the lowest score of 3.17 according to respondents' opinion is "Lecturers do attendance or check attendance through Microsoft Teams".

#### e. Description of Distance Learning Variable

The Distance Learning variable is explained into 7 (seven) instruments which are grouped into three indicators that explain distance learning using virtual application technology, flexibility to do anytime and anywhere, and materials & assignments [13]. The first indicator of distance learning using virtual application technology is described in 2 (two) instruments. The second indicator, distance learning provides flexibility in time and place, is described in 3 (three) instruments. The third indicator, distance learning, provides materials and assignments that are described in 2 (two) instruments. Based on these data, it can be explained that "Distance Learning" has a high perception of holding on to the opinions of respondents with an average value of 3.61. The X3.1 instrument has the highest score of 3.74 according to the respondent is "The lecturer explains the material through online meetings using virtual application technology". On the other hand, the X3.7 instrument has the lowest score of 3.42 according to the respondent's opinion is "The lecturer provides feedback on the assignment given so that I can understand where the weaknesses or strengths are".

#### f. Description of Acceptance COBIT Implementation Variable

The Acceptance of COBIT Implementation variable is explained into 11 (seven) instruments which are grouped into four indicators, namely performance expectations, business expectations, social influences, and facilitating conditions [26]. The first indicator, performance expectations, are described in 2 (two) instruments. The second indicator, business expectations, is described in 2 (two) instruments. The third indicator, social influence, is described in 3 (three) instruments. The fourth indicator, the facilitating conditions, are described in 4 (four) instruments. Based on these data, it can be explained that "Acceptance of COBIT Implementation" has a high perception of holding on to the opinions of respondents with an average value of 3.39. The instrument Y.1 has the highest score of 3.68 according to the respondent is "Good E-Learning Management is useful in my learning process."

On the other hand, instrument Y.6 has the lowest 3.16 according to the respondent's opinion is "The Head of the Study Program helps me in understanding the policies of running PJJ, the use of e-Learning, and Microsoft Teams."

#### g. Analysis of Research Results

Based on statistical data, the Cronbach Alpha value is 0.984, which means this value is greater than the minimum Cronbach Alpha value of 0.6. The conclusion from this is that the research instrument used in measuring the variable "Acceptance of COBIT Implementation" is reliable.

Then, from the results of validity and reliability testing, the next process can be carried out so that it will continue with classical assumption testing to provide certainty that the regression equation obtained has accuracy in estimation, is not biased, and is consistent.

Based on the normality test, it can be explained that the distribution of the data distributed throughout the curve area is normal so that it can be concluded, the data has a normal distribution, likewise with the Normal P-Plot graph. The data is distributed around the diagonal line and follows the diagonal line, which represents the normality of the research data.

**Table 2 Multicollinearity Test Results**

Variable	Collinearity Statistics	
	Tolerance	VIF
X1	0.339	2.950
X2	0.148	6.766
X3	0.242	4.124

Based on the results of statistical data processing, it can be explained that the tolerance value for X1 is 0.339, the tolerance value for X2 is 0.148, and the tolerance value for X3 is 0.242, as shown in Table 2. These three values are more significant than 0.1 and indicate that there is not a very strong correlation between each independent Variable so that the relationship between the independent variable and the dependent Variable is not disturbed. In addition, the data on the heteroscedasticity test shows that the data is spread out and does not show a certain pattern so that the overall sample data can be said to have no symptoms of heteroscedasticity.

**Table 3 T-Test Results**

Variable	Unstandardized Coefficients		t	Sig.	Remarks
	B	Std. Error			
Constant	2.654	1.228	2.162	.003	
X1	.171	.069	2.493	.004	H1 Significant
X2	.458	.129	3.560	.001	H2 Significant
X3	.555	.089	6.248	.000	H3 Significant

Based on the results of statistical processing as shown in Table 3 on the coefficients data, it is known that the significance value of X1 is 0.004. This value is smaller than 0.05 so that the first hypothesis is accepted, meaning that there is an influence of E-Learning Management (X1) on the Acceptance of COBIT Implementation (Y). Henceforth, based on the results of statistical processing on the coefficients data, it is known that the significance value of X2 is 0.001. This value is smaller than 0.05 so that the second hypothesis is accepted, meaning that there is an effect of using Microsoft Teams (X2) on the Acceptance of COBIT Implementation (Y). In the next analysis, based on the results of statistical processing on the coefficients data, it is known that the significance value of X3 is 0.000. This value is smaller than 0.05 so that the second hypothesis is accepted, meaning that there is an effect of Distance Learning (X3) on the Acceptance of COBIT Implementation (Y).

**Table 4 F-Test Results**

Model	F	Sig.
Regression	201.410	0,000 <sup>b</sup>

Based on the Summary data and ANOVA data in Table 4, it can be explained that the significance value derived from the F test is 0.000 and this value is less than 0.05, which means that the variables X1, X2 and X3 together or simultaneously have an effect on Y or are significant. This result also means that the requirements for the meaning of the coefficient of determination in the multiple regression analysis can be met. From the Summary Model data in Table 5, it can also be explained that the value of R or the value of the coefficient of determination is 0.855, which means that the variables X1, X2 and X3 together have an influence on variable Y of 85.5%, while the other 14.5% are influenced by other variables. Outside the regression equation or is also a variable not examined in this study.

**Table 5 R<sup>2</sup> Test Results**

Model	Adjusted R Square	Std. Error Of The Estimate
1	0.855	4.612

This index of 85.5% shows that the level of acceptance from students towards the implementation of COBIT within the scope of IT-related Goals is quite high, students have been using information technology services that are in line with educational needs, and students themselves have used adequate applications, information and technology solutions, university leaders have been implementing optimal IT governance and management which have been well implemented in e-learning management, optimal use of Microsoft Teams, and the implementation of distance learning in at 6 (six) higher education institutions in Batam City.

#### 4. Conclusion

From the processed data, there are 103 respondents who already have a proportion that represents all respondents who study at universities in Batam City that have distance learning technology, namely E-Learning in their teaching and learning process using Microsoft Teams technology; and most of the respondents have represented students as a dimension of the Balanced Scorecard Customer. The results of data processing with the UTAUT model state that 3 (three) hypotheses show a significant effect. E-Learning management, the use of Microsoft Teams as a virtual meeting medium, and the application of distance learning have an effect on the acceptance of COBIT implementation at universities in Batam City by 85.5% so that this allows universities to apply information technology in line with business needs and use adequate applications, information and technology solutions. Furthermore, this research can be developed by measuring Capability & Maturity Level in the primary process in order to find out how far the level of information technology governance in universities in general in Batam City is.

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# Design Thinking Method to Develop a Digital Evidence Handling Management Application

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**Abstract** - Handling digital evidence in forensics is a very crucial task. Incorrect handling can cause the evidence to become invalid as proof of a crime in court. The procedure of handling digital evidence, starting from its collection, usage, and storage, affects its acceptability in the judicial process. Therefore, a digital evidence management system becomes imperative for police researchers and investigators. This study aims at designing such a system using the design thinking method, which goes through five stages: empathy, definition, idea, prototype, and test. The result of the study is a web-based system prototype. The prototype user testing attains a system usability scale (SUS) value of 60. The SUS value means that the prototype is in the category of marginal low and indicates that the prototype does not meet the feasibility and needs improvement.

**Keywords:** digital forensics, digital evidence, digital evidence handling, design thinking

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## 1. Introduction

Each country has a different system of jurisdictions. So with these differences, the way of handling evidence against digital data is also different. In Indonesia, there are two laboratories that are already popular in handling digital evidence, namely: the Indonesian Police Forensic Laboratory Center (Puslabfor Polri) and the Indonesian Islamic University's Center for Digital Forensic Studies (Pusfid UII). Currently, the two laboratories have implemented procedures for implementing digital forensics that are in accordance with digital forensics rules. However, each laboratory certainly has different rules in handling digital evidence. In Indonesia, there is no specific standard that addresses the handling of digital evidence. Every agency that has a digital forensics division will have a standard for handling digital evidence independently. So by looking at this situation, there is no uniformity in the handling of digital evidence in Indonesia. The absence of specific standards in the process of handling digital evidence sometimes makes it difficult for an investigator to determine which procedure is best to use.

Procedures in handling digital evidence need to be carried out in accordance with certain rules and standards. This is because a digital evidence must have the feasibility to be used as evidence in the realm

of justice. Handling that is not in accordance with procedures can make the digital evidence unfit for use in trial. For example, in 2016 Indonesia was shocked by the case of cyanide coffee. The case at that time had evidence in the form of digital data, namely video data from CCTV at the scene. However, at that time digital forensic science was just developing in Indonesia, so the trial process and the process of investigating digital evidence seemed difficult in the process. One opinion is that this is because the court is not ready to accept digital evidence to be used as evidence. At that time, there was no full socialization of legal experts and courts on how to treat digital evidence. As a result, the authenticity of the evidence is questioned. This makes it more difficult to determine who the perpetrator is.

Another problem faced in the handling of digital evidence is that digital evidence is very easy to modify, so that the authenticity of the data may be lost along with the wrong treatment process for handling digital data [1]. So that it is easy to modify it, this is what causes the process of handling digital evidence to be more difficult to do compared to handling physical evidence [2]. Handling digital evidence according to rules and standards is very crucial. Research conducted by Matthew Braidd [3] states that digital evidence that can be used in the realm of trial must have five criteria: admissible, authentic, complete, reliable, and believable.

Then the research conducted by Schatz [4] states that there are two decisive aspects: the legal aspect and the technical aspect. Based on several explanations of these problems, in the process of handling digital evidence, special procedures are needed.

Currently, there are many procedures and standards in the handling of digital evidence, but it will not cover all investigators who fully understand the handling, sometimes the process of handling digital evidence is still done manually and has not been stored digitally and follows digital standards and rules. So, to make it easier for an investigator to handle digital evidence and make it easier to manage digital evidence, a web-based digital evidence management system was created..

Before implementing a system to be built, the first step is to design the system. This is done to conduct a needs analysis of user needs. The user of the system in question is an investigator and analyst.

The system will be designed using a design thinking approach. Design thinking is an iterative process in which developers seek to understand users and their assumptions, and redefine the problem in an attempt to identify alternative strategies and solutions. The design thinking approach provides a solution-based approach in solving problems [5]. The choice of this design thinking approach method is used because the design can be done by looking at empathy from the user's side. The use of design thinking can help to question the problem, its assumptions, and its implications. This method also involves a lot of experimentation, such as sketching, prototyping, testing, and trying out concepts and ideas.

To meet the standards in the management of digital evidence handling that will be poured into web-based applications, a system business process rule is needed. The system business process in handling digital evidence refers to the framework that has been made in the research of Lizarti, et al [6].

The results of this study are in the form of a system prototype which will then be tested using usability testing. The result of usability testing is 60 which the prototype that has been designed still does not meet the eligibility criteria for use. This is because the system is still difficult to use and still not consistent in providing its features.

## 2. Method

The method of designing a digital evidence handling system follows a design thinking approach. Design thinking is an innovative and sustainable method of development. It is said to be innovative and sustainable because this method is based on user needs. So that the design of a system will always be adjusted to the user's needs for the system [7]. Users of this system have been described in Table 4, namely first responders and forensic analysts. The need in question is the need for features that will be implemented into the application according to the needs when handling digital evidence. There are several core stages of the design thinking method: empathy, definition, idea, prototype, and test. The research flow that has been collaborated with design thinking is depicted in Figure 1.

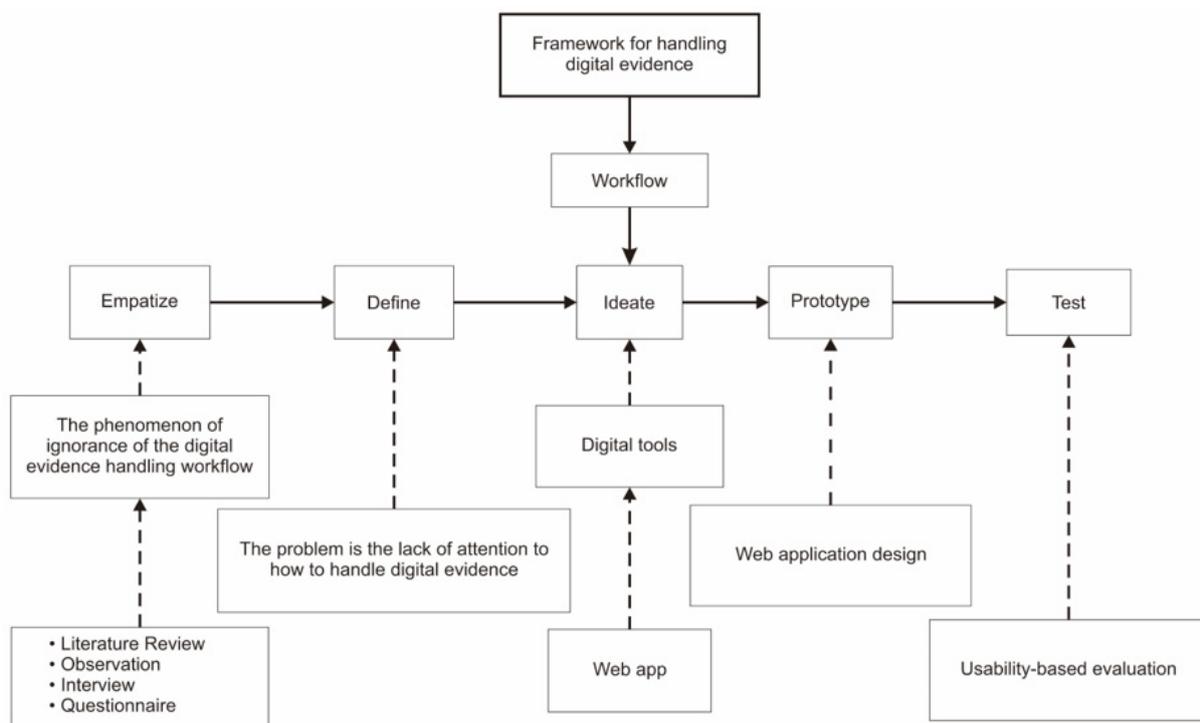


Figure 1. The workflow

The description related to Figure 1 is as follows:

a. Empathy

In this stage, the process of literature review, observation, interviews, and giving questionnaires to prospective users is carried out. This is done to the phenomenon of ignorance of the flow of handling digital evidence. So that this stage aims to equalize the perception of needs between users and the system to be built.

The literature review was carried out by taking sources from Google Scholar, Scopus, and Science Direct with a span of 10 years of research on the theme of handling digital evidence. The selection of these three study sources is due to obtain a richer and more complete study. In this paper, the number of literatures obtained is 175 literatures, then 3 literatures are selected according to the problems in the management process for handling digital evidence.

Observations were made by participating in discussions related to digital forensics with the Kominfo and government agencies. Discussions were held by attending seminars related to the handling of digital evidence and digital forensic laboratory standards.

The observation process is a process of checking the frameworks for handling digital evidence and existing rules. Then observe the actors involved in the process of handling digital evidence. Based on the paper written by Subektiningsih, that the actors involved in the process of digital forensics activities are: (1) First responders; (2) Investigators, Digital Investigators, Forensic Investigators; (3) Police officers; (4) IT Professional.

The next stage is interviews with experts and practitioners who are experienced in the world of digital forensics. Interviews were conducted to find out what problems were encountered at the digital forensics stage, especially the process of handling digital evidence. The interview process was carried out by giving questionnaires to two practitioners as well as academics and 1 practitioner. Interviews were conducted with 3 digital forensics experts, namely academics and practitioners. Interviews were conducted simultaneously with giving questionnaires related to problems in digital forensics in general and the process of handling digital evidence. The questionnaire was given by asking questions related to the theme of the paper.

b. Definition

This stage is a continuation of the first stage which is the process of defining what needs will be given to the system to be built based on the problems encountered in the first stage..

The problem definition process uses a point of view template by describing the problem from the user's side, needs, and point of view. User descriptions are taken from the interview process with digital forensics experts who were carried out at the empathy stage.

The result of the definition process in the form of features to be created will have three actors: system admin, main responder, and forensic analyst. The features that will be provided on the system include: (1) The system has

integrated storage media with the cloud; (2) The system has good data communication security, in accordance with data communication security rules; (3) The system has a data authentication model regarding who can access the data.

c. Idea

This stage is the determination of the solution to the system to be built. This stage is a stage for brainstorming, noting all ideas. The digital tool that will be used in this system is a web application.

Brainstorming is done by referring to the process of empathy which is described in the form of mapping ideas. The results of the mapping are then taken from the core ideas that will be implemented using the now wow how matrix. The selection of ideas is done using the Now Wow How Matrix method by sorting the ideas obtained during brainstorming into three quadrants. The three quadrants are How, Now, and Wow. Now is an idea that can be implemented immediately without seeing its novelty. Wow is an implementable and innovative idea. How is an idea that can be implemented in the future.

d. Prototype

This stage has entered the design model of the system to be created. In this paper, a prototype model is made based on the usertask flow and application flowchart. Usertask flow is used to map the flow of system usage based on the user side. Then the application flowchart is used to map how the application flows to the user.

e. Test

The model that has been made based on the previous stages will be tested on potential users, if there are improvements, an improvement process will be carried out and will be re-tested to potential users. The testing process is carried out using usability testing with the System Usability Scale (SUS) method to see how feasible the application is. Data was taken using a questionnaire. The questionnaire was addressed to 3 digital forensics experts, namely academics and practitioners.

The SUS method uses a Likert Scale with a coverage of 10 statements. Questionnaire participants will give a rating of 1 to 5 based on how much they agree with the statements given. 5 means strongly agree and 1 means completely disagree. Based on the SUS method, to get the SUS score, the result of the average score of each odd-numbered question is subtracted by 1 point and 5 points is subtracted from the result of the average score of each even-numbered question. After subtracting, the odd-numbered and even-numbered questions are added up and the result is multiplied by 2.5.

The overall result of the calculation is a score of 100. This calculation is not a percentage, the results directly point to the score of the assessed system.

To determine the level of user acceptance, the method of writing made by Brooke, 2013 [8] is used. Determination by looking at the level of user acceptance by

dividing it into three categories: not acceptable, marginal, and acceptable can be seen in Figure 2.

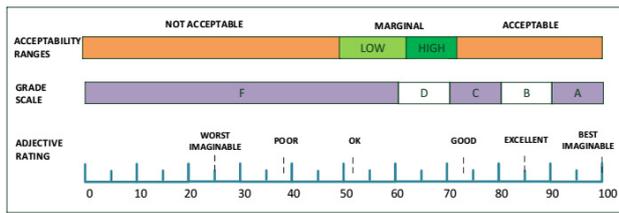


Figure 8. SUS Score [8]

### 3. Result

The following is the result of a system design based on a design thinking approach.

#### a. Empathy

This stage is carried out several steps including literature review, observation, and interviews with experts and potential users. Table 1 is the result of a literature review related to the problems faced in digital forensics. The literature was selected based on the focus of research related to the theme of the paper and based on the nearest 10 years. The literature selection was taken from several journal sources using the Google Scholar search engine. Research on handling digital evidence is focused on security and the digital chain of custody.

Table 1. Literature review of problems in digital forensics

Researcher	Title	Problem
Prayudi dkk, 2015 [8]	Digital Chain of Custody: State of The Art	The challenge faced by investigators is how to handle digital evidence
Sadiku dkk, 2017 [9]	Digital Chain of Custody	The most important part of the investigation process is the digital chain of custody (COC).
Richter & Kuntze, 2010 [10]	Securing Digital Evidence	Every piece of evidence in order to be used and support the legal process must have proper procedures in handling digital evidence

The results of observations on digital forensics rules and frameworks can be seen in Table 2. The results of observations refer to the results of studies of research journal literature. Literature review of digital forensic frameworks is presented in Table 3.

Table 2. Observation of digital forensics rules and framework

Framework/ Rule	Information
Association of Chief Police Officer (ACPO)	Consists of five stages: preparation, preserving, collecting, confirming, identifying.
SOP Laboratorium Forensika Digital POLRI	The procedure consists of 15 SOPs related to digital forensics

Framework/ Rule	Information
Association of Chief Police Officer (ACPO)	Consists of five stages: preparation, preserving, collecting, confirming, identifying.
National Institute of Justice (NIJ) U.S Department of Justice	Consists of five things that are carried out in conducting digital forensic analysis, making policies and procedures, digital evidence assessment, digital evidence retrieval, digital evidence analysis, and documentation and reporting
Jurisdiction Rules No, 10/2020	Regarding the procedures for handling digital evidence by the Indonesian National Police

Table 3. Literature review of digital forensics framework

Researcher	Title	Information
Rhee, 2012 [11]	Framework of multimedia forensic system	Multimedia forensics framework using composition
Lizarti, 2017 [12]	Penerapan composite logic dalam mengkolaborasi framework multimedia forensik	Building a multimedia forensics framework using a composite logic approach
Ledesma & M.S., 2015 [13]	A proposed framework for forensic image enhancement	Digital image forensics framework in the image enhancement section
AlShaikh dan Sedky, 2015 [14]	Post incident analysis framework for automated video forensic investigation	Post incident framework for video forensics investigation automation
SWDGE, 2010 [15]	SWDGE Minimum requirement for quality assurance in the processing of Digital and Multimedia Evidence	Minimum requirement for multimedia forensic investigation

#### b. Definition

The problem definition process is carried out by defining the problem based on the point of view referred to from the results of the literature review that has been carried out in the empathize section. Table 4 is the result of defining the problem from the user side of the system. In Table 4, the definition of users who will use the system is two people, namely first responders and forensic analysts.

Table 3. Point of view template for defining problems from the user's point of view

User	Needs
First responders (network administrators, investigators, law enforcement officers)	Media to protect, integrate and preserve evidence obtained from crime scenes.
Forensic Analyst	Media for safe storage and retrieval of evidence

The results of the interview stage, some of the problems faced in handling digital evidence for multimedia data are the absence of operational standards for the process of handling digital evidence. In addition, there is a lack of knowledge on how to operate the handling of digital evidence owned by actors. Definition of functions, features, and elements: in this section will be defined service requirements that will exist in a system.

c. Idea

The ideas of the process of looking for ideas are taken from the previous process of empathizing and defining. There are three user needs that serve as a reference for designing applications in this paper. These requirements

consist of application features, management, and digital tools. Application features relate to the services that will exist in the application. Management of digital facilities relates to the media used to implement the system.

In the digital facilities section, the results of the brainstorming noted the need for digital facilities that can be used on the system, namely web applications and mobile applications. Then the results of brainstorming for management include: flow of use of digital evidence, framework for handling digital evidence, storage media, mechanisms, and personas involved in the system. For application features, the results of brainstorming are the type of storage media, data communication security, chat, and file sharing.

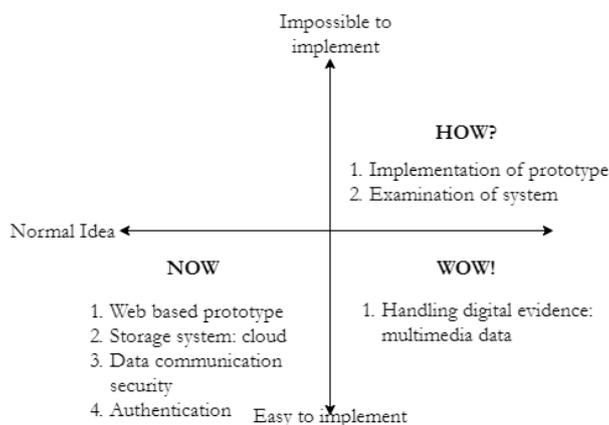


Figure 3. Now Wow How Matrix

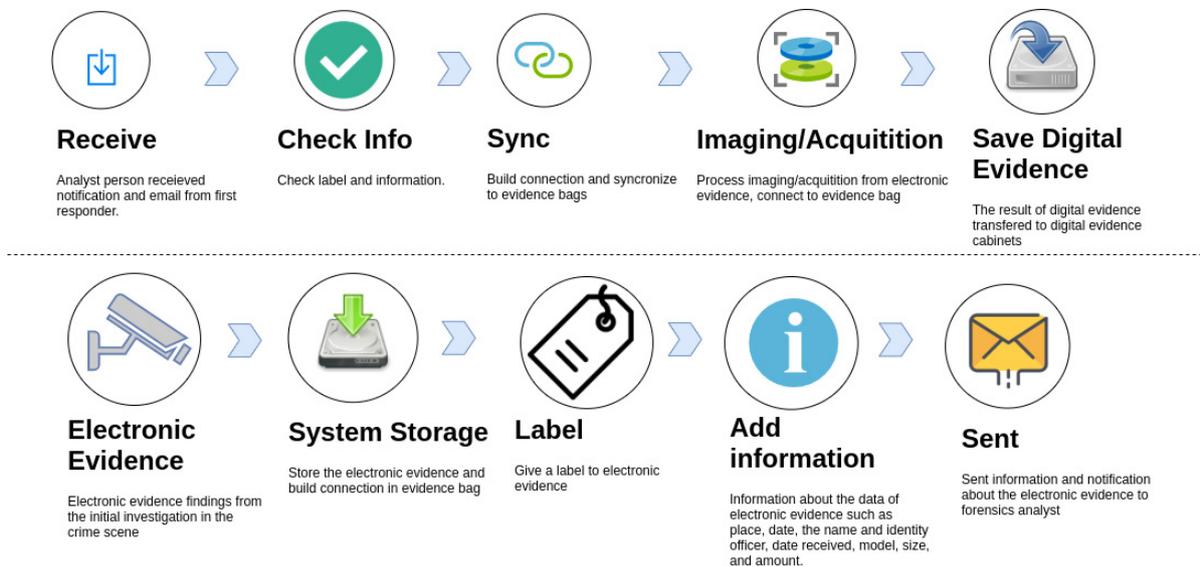


Figure 4. User task flow

The ideas from the brainstorming results are then selected using the Now Wow How matrix. The selected ideas are taken based on the parameters now, wow, and how. The results of the now wow how matrix are as follows:

1. How: prototype implementation and testing
2. Wow: handling of digital evidence for multimedia data

3. Now: web-based prototypes, storage media using cloud technology, data communication security, and user authentication.

Based on the matrix shown in Figure 3, the implementation is chosen in the now matrix section: a web-based prototype using cloud-based storage media,

data communication that has security, and there is an authentication system for system users..

d. Prototype

The business process of handling digital evidence is referred to from research conducted by Prayudi et al. The stage of handling digital evidence involves an officer, investigator, law enforcement, and first responder. So that in the prototype to be made, the actors involved are first responders, forensic analysts, and system admins. To determine the activities of the actors involved, it refers to the basic assumptions of the digital forensics business model proposed by Prayudi et al [16].

So that the user task flow is made based on the digital forensics business model proposed by Prayudi, et al. The usertask flow is depicted in Figure 4. Main responders: find evidence and collect evidence and then give it to forensic analysts. So that what can be done to the main responders in the system are: (1) Providing notifications to

forensic analysts to carry out imaging actions/acquisition of electronic evidence via email; (2) Record information and information regarding evidence through a system in the form of photos and information on evidence labels (name of sending institution, name of sending officer including complete identity, amount of evidence, brands of evidence, size); (3) Storing evidence in the evidence bag (a stand-alone system).

Forensic analyst: performs the acquisition/imaging of electronic evidence into digital evidence. The process of acquisition/imaging and analysis is done outside the system. So that forensic analysts use the system to: (1) Connect and request authentication with the evidence bag system; (2) Record information on electronic evidence (name of sending institution, name of sending officer including complete identity, date received, amount of evidence, brands of evidence, size); (3) Storing the acquisition results on cloud storage media called digital evidence cabinet.

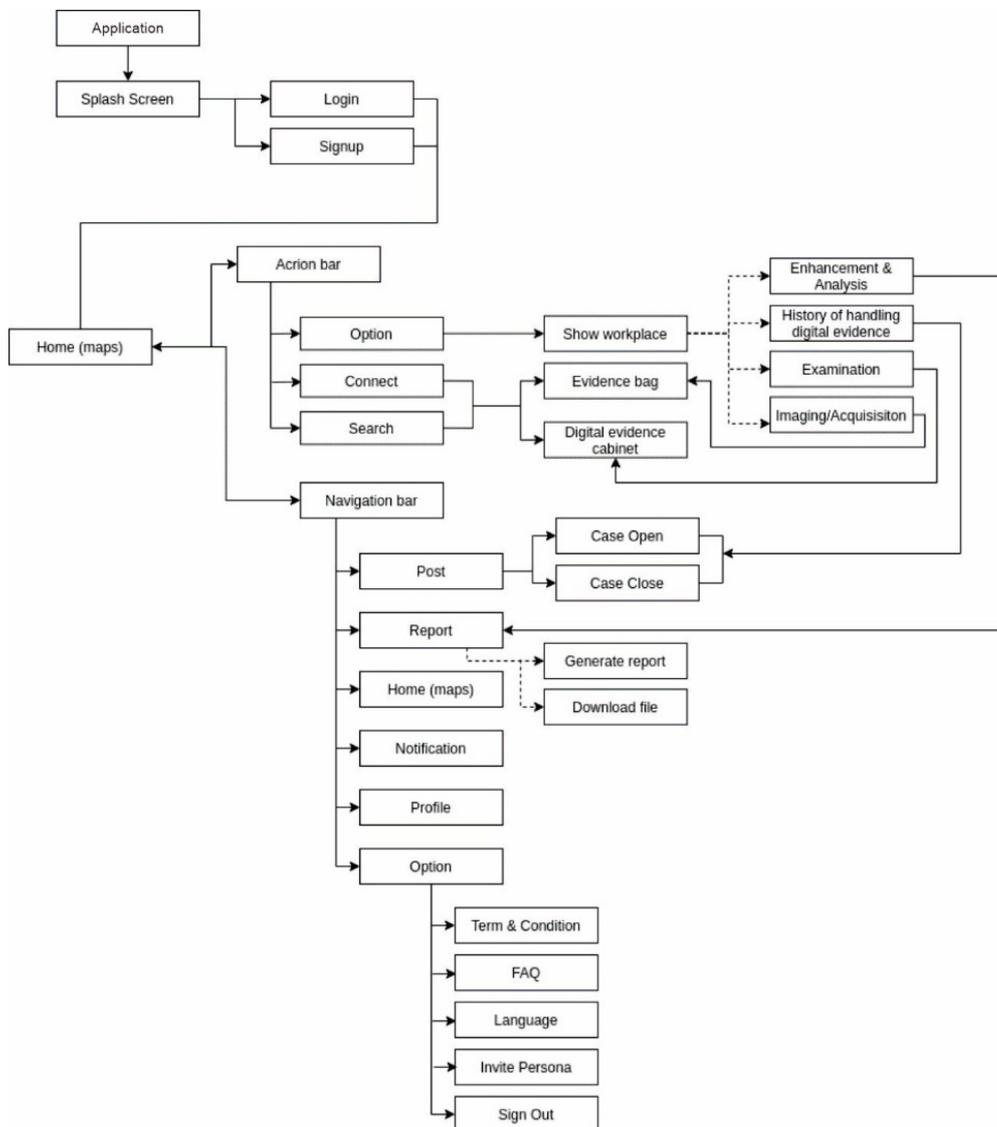


Figure 5. Flowchart of the application

The flowchart stages shown in Figure 5 are the workflow of the prototype to be made. This process begins with a splash page in the form of a logo display from the application that has been created. Furthermore, the user will enter the login page or sign up if the user does not have an account. After logging in, the user will enter the home page where there is an action bar in the middle of the page and a navigation bar at the top of the page.

In the action bar there are 3 options, namely the button option which refers to the show workplace page which contains enhancement & analysis, history of handling digital evidence, examination and imaging/acquisition, then connect and search buttons which refer to the evidence bag folder and digital evidence cabinet folder.

While in the navigation bar there are five choices, namely home which refers to the first page after the user logs in, then the case button which refers to the case open and case closed pages, then the report button which refers to the generate report page and download the file, after that there is a button options that refer to the terms & conditions page, FAQ, language, invite persona, and sign out, and the last button profile which refers to the profile page, and notification button.

After the prototype is made, then testing is carried out on the user. The results of improvements to the prototype are carried out in two iterations. The first iteration is an improvement in the connection process for access to digital evidence bags and digital evidence cabinets. Then the second iteration, improvements to the navigation bar in the post.

#### 5. Test

At this stage, trials will be carried out on the prototype that has been made in the previous sub-chapter using usability testing by giving questionnaires to several potential users. The results of the questionnaires that have been given will be assessed using the System Usability Scale (SUS) to get the measurement results of the prototype being tested for potential users. The results of the questionnaire were then calculated using a predetermined formula to get the SUS score. The results of the SUS score assessment are shown in Table 5.

**Table 4. SUS score calculation results**

No	Question	Average
1	I will use this system again	3.5
2	I find this application system complicated to use but it could be simpler	2.5
3	I find this application system easy to use	3.5
4	I feel that I need the help of other people or technicians to use this application	3
5	I found various features well integrated in the system	4
6	I feel there are a lot of inconsistent things in this app	2.5

No	Question	Average
7	I think many users will quickly learn this system	3.5
8	I find this feature very handy when used	3
9	I can use this system well	3.5
10	I need to get used to it first in using this system	3

The results of the calculation provide the SUS value of 60. In the SUS assessment, the system can be categorized as acceptable if the SUS value is more than 70. Based on the calculation of the SUS value, the Digital Evidence Handling Management prototype gets a score of 60. The value of 60 is included in the marginal low category. Marginal low has a minimum value of 50. The Digital Evidence Handling Management Prototype does not meet the eligibility category because it does not meet the acceptable category. The causes of not meeting the acceptable category can be seen in Table 5, the smallest value of 2.5 indicates that users still find difficulties to use the application and feel that there are still parts that are not consistent in the application.

#### 4. Conclusion

The study has constructed a prototype of digital evidence handling management application. The prototype user testing gives a SUS value as low as 60, which falls into the marginal-low category. The system still needs improvement in terms of convenience and consistency. The design thinking method shows that the design process focuses more on exploring problems and providing solutions. For this reason, as a refinement of the system, in the future, more in-depth research should be carried out related to the design and implementation directly into a system. The recommended method for system improvement is the user-centered design method because it focuses more on user needs and is suitable for software development.

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# Automatic Gate for Body Temperature Check and Masks Wearing Compliance Using an Embedded System and Deep Learning

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**Abstract** - A new coronavirus variant known as n-Cov has emerged with a fast transmission rate. The World Health Organization (WHO) has declared the related disease or COVID-19 as a global pandemic that requires special handling. Many parties have shown efforts to reduce virus transmission by implementing health protocols and adapting a new normal lifestyle. Implementation of the health protocol creates new problems, especially in the health check at the main entrance. The officers in charge of measuring body temperature are at risk of getting infected by COVID. Such a measurement is prone to errors. This study proposed a solution to build an automatic gate system that worked based on the new normal health protocol. The system utilizes the MLX90614 contactless temperature sensor to probe body temperature. It applies deep learning implementing the Convolutional Neural Network (CNN) algorithm with the MobileNetV2 architecture as a determinant of the conditions of wearing face masks. The system is equipped with an IoT-based remote controller to control the gate. Experimental results prove that the system works well. Temperature measurement takes a response time of 20 seconds for each user with 99% accuracy for the sensor and masks classification model.

**Keywords:** COVID-19, face mask classification, convolutional neural network, MobileNetV2, MLX90614

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## 1. Introduction

Coronavirus Disease 2019 (COVID-19) is an infectious disease caused by a novel corona virus variant discovered in 2019. COVID-19 causes diseases in humans such as the flu, with a very fast transmission through physical contact interactions or with other media within a close range [1]. The World Health Organization (WHO) has determined that the spread of COVID-19 is a global pandemic that requires special handling to suppress its transmission. The COVID-19 virus has spread in several regions of Indonesia with the number of cases reaching 45892 cases, and the ratio of patients recovering 40% and dying by 5% [2]. The Indonesian government to handle COVID-19 cases has implemented several policies such as Large-Scale Social Restrictions (*Pembatasan Sosial Berskala Besar - PSBB*), Enforcement of Community Activity Restrictions (*Pemberlakuan Pembatasan Kegiatan Masyarakat - PPKM*), and adaptation for a new normal

lifestyle. The implementation of the new normal lifestyle is carried out to break the chain of the spread of the COVID-19 virus in line with economic and community activities that must remain active during this pandemic. The ITERA's environment also adapts the implementation of the new normal protocol to deal with the activities of the academic community that cannot be done online. ITERA through the New Life Adaptation Development Agency (*Badan Pembina Adaptasi Kehidupan Baru - BPAKB*) ITERA Campus has compiled a new normal protocol with the standards set by the Ministry of Education and Culture (Kemdikbud). The new normal protocol implemented consists of several main points such as the body temperature and the use of mask checks which are carried out at the ITERA main gate (one gate system) [3]. The gate is used as an intermediary and controls the incoming and outgoing vehicles [4], as well as the academic community. Every ITERA academic community who wants to enter the ITERA's environment need to go

through body temperature and mask-wearing check by ITERA officers. The checking is carried out by officers at the main gate caused various problems, such as a high risk of transmitting the virus to officers and the emergence of queues if the number of visitors was not proportional to the number of existing officers.

Of the various problems that arise due to body temperature and masks wearing checks by officers, it is necessary to have a system that can replace the role of officers and can be integrated automatically through the campus gate. Research related to the development of an intelligent system connected to the gate has been carried out previously, in which the gate can be opened through facial recognition using the HAAR Cascade algorithm [5]. Another similar development has also been carried out previously to deal with influenza by measuring normal body temperature without contact using MLX90614 in monitoring attendance at schools [6]. In addition, research related to the face mask detection model can produce 2-3% better accuracy on public datasets, through the application of the MobileNetV2 architecture [7].

Based on the explanation of previous studies, in this study, an automatic gate system was developed using the MLX90614 sensor to measure non-contact body temperature, which has good accuracy [8], and the MobileNetV2 architecture to categorize the use of masks by considering the low model size, as well as quite capable computing.

## 2. Method

The research methodology used in this study consists of several stages as shown in Figure 1.

### a. Problem Identification

The initial stage carried out in this research is the identification of the problem, (especially to reduce interaction of officers) at the ITERA campus gate with an automatic gate system that can check the temperature and detect the use of masks.

### b. Literature Studies and Literature Studies

The literature study was conducted to obtain relevant references related to the research. The references used are sourced from various domestic and international journals regarding the methods and objects studied to avoid repeated research. The literature study was conducted to obtain the basic and conceptual theory that underlies this research. Some of the basic theories in this research are:

#### a) Computer Vision

The technology which is development part of artificial intelligence, has an important role in processing images and videos by an electronic machine. The application of computer vision in various systems has the main goal of being able to imitate the ability of the human eye so that machines can recognize objects through images or videos provided. In addition to imitating the human ability to see, several

important things need to be considered in the field of Computer Vision, specifically systems with low power and resources but still running powerful [9]. Currently, the use of computer vision has expanded and is widely used in the development of intelligent devices capable of detecting and recognizing various objects such as faces (Face Recognition) and other objects [10].

#### b) Body temperature

Temperature is the level of hot or cold in a situation that can be measured using an instrument called a thermometer. Body temperature is generally divided into two types, namely skin/surface temperature and core temperature. The temperature on the inside of the body is called core temperature, which has a constant level in the non-febrile condition, which is around  $\pm 1^{\circ}\text{F}$  ( $\pm 0.6^{\circ}\text{C}$ ). Furthermore, skin temperature is the level of heat found on the surface of the skin, with fluctuating values because it can be influenced by the state of the ambient temperature. If excessive heat is formed in the body, then the skin temperature will rise, and vice versa. In general, the normal human body temperature ranges from  $97^{\circ}\text{F}$  ( $36^{\circ}\text{C}$ ) –  $99.5^{\circ}\text{F}$  ( $37.5^{\circ}\text{C}$ ). Body temperature can also be affected by the activities carried out, for example, the temperature will rise when doing sports or other physical activities. In addition, extreme environmental temperatures can also affect body temperature [11].

#### c) MobileNetV2

MobileNetV2 is a neural network architecture that was developed to overcome the problem of limited mobile device resources with several improvements to support efficiency [12]. MobileNetV2 development is done by reducing the number of operations and memory usage while maintaining the accuracy of the model. MobileNetV2 can be implemented efficiently on a variety of standard operations and modern frameworks. In addition, MobileNetV2 is very suitable for the implementation of embedded systems because it allows memory reduction during the use [13].

#### d) OpenCV

OpenCV is an open-source library that can be used for computer vision applications. Initially, this library was developed to accelerate the performance and capabilities of computing machines in the fields of computer vision and artificial intelligence by providing robust infrastructure. OpenCV, which was developed using the C and C++ programming languages, can operate well on several operating systems such as Linux, Windows, and macOS [14]. In addition, development is also carried out in several other programming languages and interfaces such as Python, Java, Matlab, and others. OpenCV provides an infrastructure that makes it easier for users to apply computer vision concepts (e.g., image

processing). Currently, OpenCV contains more than 500 functions that can be applied to various problem areas such as health, security, and others [15].

e) Tensorflow

Tensorflow is a widely used library for deploying and developing deep neural networks which is developed by the Google Brain team. Tensorflow is an open source machine learning system that can operate in heterogeneous environments. Tensorflow uses dataflow to represent computations, shared states, and other operations. It maps each node of the dataflow graph on multiple machines within a cluster, and on each machine across multiple computing devices such as multicore CPUs, general-purpose GPUs, and custom-designed ASICs known as Tensor Processing Units (TPUs). This architecture gives developers flexibility in designing parameters and managing shared states on the system [16].

c. System planning

The design of the system aims to compile component and system requirements. In addition, at this stage, the circuit and workflow of the system are also made. In the development of this automatic gate system, there are several main requirements needed to build a smart device that is integrated with the gate. The main requirements needed for this automatic gate system can be observed in Table 1.

Table 1. Hardware requirements

No	Name	Function
1	Raspberry Pi 4 Model B	A microcontroller that has a role as a data processing center, which can work in three stages, namely Input, Process, and Output.
2	MLX90614	A non-contact temperature sensor that functions to measure body temperature by utilizing a passive infrared mechanism.
3	Raspberry Pi Camera	Retrieve image data in image or video file types to be used as input data.
4	Raspberry Pi Display / Monitor	Graphical data viewer generated from microcontroller processing.
5	Relay	A switch that serves as a controller and a large electric current with a small electric current control.
6	HC-SR04	The ultrasonic sensor serves to measure the distance of the object relative to the sensor.
7	MicroSD	A tool that is used as storage space for the operating system and other files on the Raspberry Pi.

The automatic gate system was developed using the Raspberry Pi4 microcontroller as a center for processing data obtained from sensors and cameras. In addition, actuators in the form of relays are also controlled by a

microcontroller based on data validation that has been obtained previously. The interaction between each component can be represented through a schematic diagram which can be seen in Figure 2.

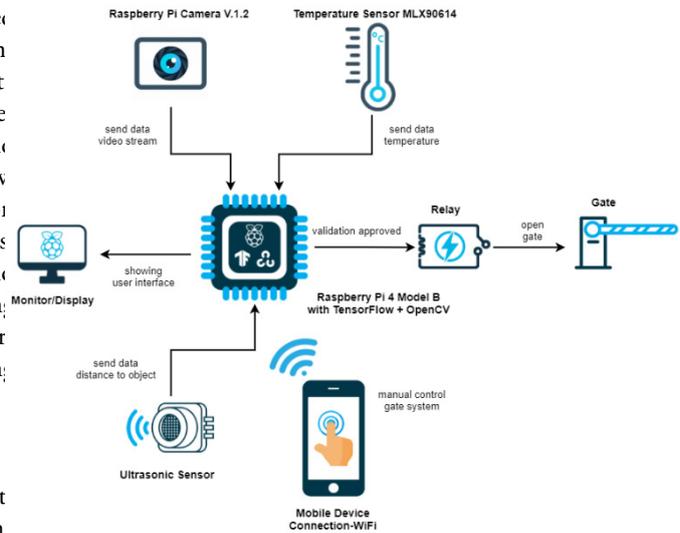


Figure 2. System schematic diagram

The workflow of the automatic gate system is designed according to the defined new normal protocol. To open the gate, two methods can be done, the system must check the user's compliance with the new normal protocol through the body temperature checks and the use of masks detection. The workflow of the gate system is represented through a block diagram which can be observed in Figure 3.

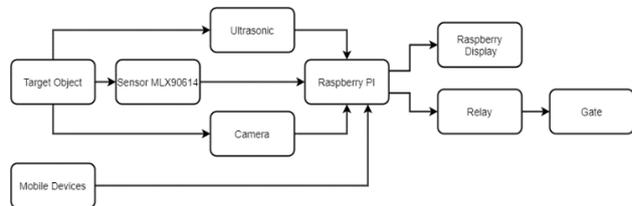


Figure 3. System block diagram

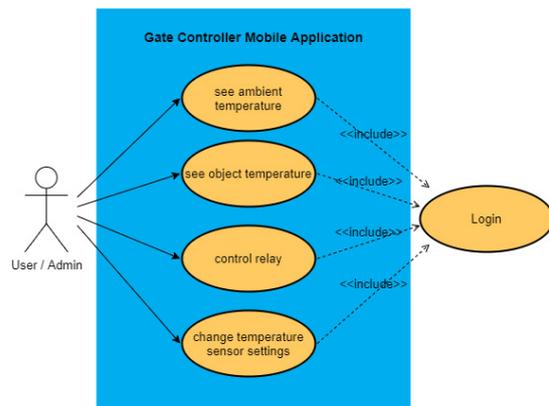


Figure 4. Mobile applications use case diagrams

In addition, the gateway system can be controlled remotely by utilizing an Internet connection and a mobile

device. The software for controlling the gate system generally consists of several functions which can be seen through the use case diagram in Figure 4.

#### d. Dataset Preparation

The dataset is a collection of data that is used to develop an existing face mask classification model. In this study, there are three sources of the dataset used, which are then used to form the most optimal model to be implemented in the system. The source of the dataset is obtained through the Kaggle data scientist platform. Dataset specifications can be seen in Table 2.

The dataset used contains a collection of images with the extension \*.jpg or \*.png. The image is divided into two labels/classes, 'with\_mask' and 'without\_mask' labels which are arranged into two different folders with the same composition so that the dataset is in a balanced state.

Table 2. Dataset specifications

Dataset	Number of Class	File Type	Data with mask	Data Without Mask	Number of data	Source
1	2	*.jpg	3725	3828	7553	[17]
2	2	*.png	220	220	440	[18]
3	2	*.jpg	208	131	339	[19]



Figure 5 Example of an image on a dataset

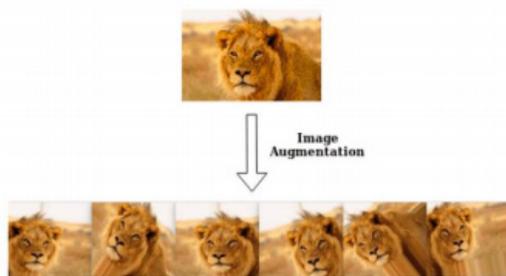


Figure 6. Illustration of image augmentation

#### e. Data Pre-Processing

This stage is useful for processing and manipulating datasets before they are included in the model or training process. Data pre-processing includes label transformation, data sharing, and data augmentation. The label transformation is done to change the data label ('with\_mask', 'without\_mask') into a NumPy array [1,0]

so that it can be used in the model creation. Data sharing is done to divide the entire dataset into two parts, 75% of training data and 25% of testing data. Data Augmentation is a step taken to enrich data by manipulating a set of images. Augmentation is useful for assisting the model in generalizing features and increasing accuracy, especially during training [20]. In the field of computer vision, augmented data can be generated by performing geometric transformations on the original image, so that another image is obtained. The geometry transformation process carried out generally includes several processes such as translations, rotations, scaling, shearing, zoom, and flip. An illustration of image augmentation can be seen in Figure 5.

#### f. Model Development

The model creation stage is done by designing the model architecture and training the model based on the dataset that has been prepared before the data pre-processing stage. The face mask classification model created uses the MobileNetV2 architecture as the base model, while the fully connected layer is arranged according to the dataset and needs. In general, MobileNetV2 still has the same architectural form as MobileNetV1, but this architecture has two additions facility, namely the existence of linear bottlenecks and shortcut connections. MobileNetV2 consists of a convolution layer using 32 filters, followed by 19 residual bottleneck layers. In addition, MobileNetV2 uses ReLU6 for non-linearity transformation [13]. A simple visualization of the working architecture of MobileNetV2 can be seen in Figure 6.

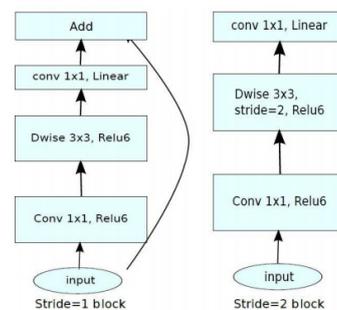


Figure 7. MobileNetV2 Architecture

MobileNetV2 architecture generally consists of layers that are arranged in such a way. MobileNetV2 has layers with specifications as shown in Table 3.

Table 3. The basic architecture of MobileNetV2

Input	Operator	t	c	n	s
$224^2 \times 3$	conv2d	-	32	1	2
$112^2 \times 32$	bottleneck	1	16	1	1
$112^2 \times 16$	bottleneck	6	24	2	2
$56^2 \times 24$	bottleneck	6	32	3	2
$28^2 \times 32$	bottleneck	6	64	4	2

Input	Operator	t	c	n	s
14 <sup>2</sup> x 64	bottleneck	6	96	3	1
14 <sup>2</sup> x 96	bottleneck	6	160	3	2
7 <sup>2</sup> x 160	bottleneck	6	320	1	1
7 <sup>2</sup> x 320	conv2d 1x1	-	1280	1	1
7 <sup>2</sup> x 1280	avgpool 7x7	-	-	1	-
1 x 1 x 1280	conv2d 1x1	-	k	-	-

In this study, the default fully connected layer on MobileNetV2 was not used and was redesigned to match the face mask classification and dataset used. The fully connected layer used can be seen in Table 4.

The fully connected layer consists of 5 layers connected to the MobileNetV2 base model, in which there is a 2D average pooling layer with a pooling size of 7 x 7, followed by a flatten layer, relu with 128 dense, 0.5 dropout, and softmax activation function with size 2.

**Table 4. Customized fully connected layer components**

Input	Operator	t	c	n	s
7 <sup>2</sup> x 1280	avgpool2D 7x7	-	-	1	-
1 x 1 x 1280	flatten	-	-	1	-
1280	relu	-	-	1	-
128	dropout	-	-	1	-
128	softmax	-	2	1	-

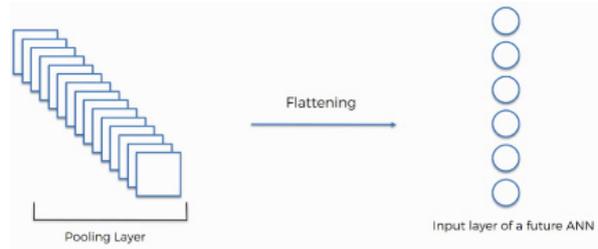
Layer pooling is generally used to reduce the size of the matrix. Layer pooling is a filter that has a certain size and will alternately shift in the feature area. A simple application of the processing applied to the pooling layer can be seen in Figure 7.

4	3	1	5
1	3	4	8
4	5	4	3
6	5	9	4

$$\text{Avg}([4, 3, 1, 3]) = 2.75$$

**Figure 8. Illustration of average pooling process**

Average pooling is one type of layer pooling that calculates each block of values through the average function [21][22]. The next stage is flattening, which is a layer with the function of “flattening” the matrix into a form that is easily spreadable into neural networks. Figure 8 provides a visualization of the simple process of flattening, with a focus on allowing data in the form of a matrix to be entered into the input layer of the neural network.



**Figure 9. Flattening process illustration**

Furthermore, on the neural network layer components, Relu is used as an activation function to convert each linear component into non-linear ones. Formula (1) can be used to calculate the relu activation function [23][24].

$$f_{Relu}(h_i, x) = \max(0, h_i, x) \tag{1}$$

Relu in general only makes a limit on the number zero which means if the value of x is 0 then x = 0 and if x > 0 then the value of x remains.

At the end of processing the neural network layer, the Softmax function is used which is an activation function in the output layer. Softmax can be used to classify multiple classes [25]. This function generally calculates each probability of some cases, which in this case calculates the probability of the label to be classified by the model. The output of this function is a range of probability values from zero to one. Softmax activation function can be calculated by equation (2) [26][27].

$$\sigma(\vec{z})_i = \frac{e^{z_i}}{\sum_{j=1}^K e^{z_j}} \tag{2}$$

Information:

- $\vec{z}$  = vector input in the softmax function, consisting of (z0...zK)
- $z_i$  = the input vector element is a real number
- $e^{z_i}$  = fungsi eksponensial yang diterapkan pada setiap  $z_i$
- $\sum_{j=1}^K e^{z_j}$  = normalization term to ensure that the output is a valid probability distribution
- K = number of classes

After designing the model, the next step is training process, where there is a hyperparameter configuration that is used to optimize model training to form a good model [28]. The hyperparameter consists of batch size, learning rate, and the number of epochs used. The hyperparameters used in the mask classification model training process can be seen in Table 5.

**Table 5. Component hyperparameter used**

Dataset to-	Epochs	Learning Rate	Batch Size
1	10	0.0001	64
2	20	0.0001	32
3	20	0.0001	32

The training process that has been carried out will produce a model which will later be implemented in the system. In addition, the resulting model can be seen from the evaluation results through the Classification Report which consists of Precision, Recall, and F1-Score. Precision (Positive Predictive Value) [29][28] is an evaluation result that describes how accurate the requested data is with the classification results or predictions given. Precision can be calculated by applying equation (3).

$$\text{precision} = \frac{\text{True Positive (TP)}}{\text{True Positive (TP)} + \text{False Positive (FP)}} \quad (3)$$

Recall/Sensitivity (True Positive Rate) is an evaluation result that describes the success of a model in finding data in a certain class/label. Equation (4) can be applied to obtain the recall value.

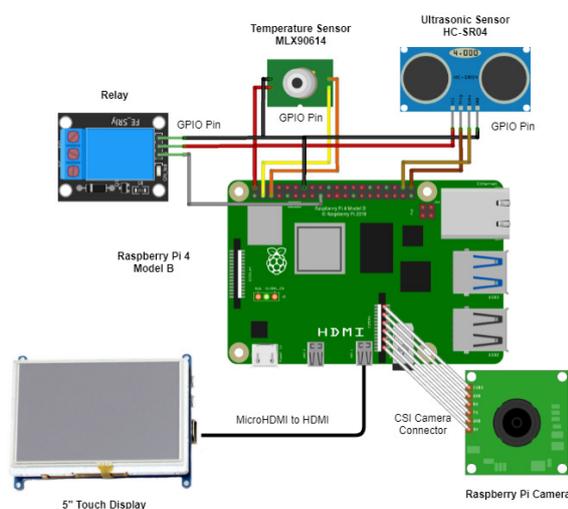
$$\text{recall} = \frac{\text{True Positive (TP)}}{\text{True Positive (TP)} + \text{False Negative (FN)}} \quad (4)$$

In the end, the classification quality calculation ends with a comparison of the F1-Score values, which compares the average value of precision with weighted recall. F1-Score, through equation (5), can describe the performance if the number of FP and FN is not balanced (non-symmetric)

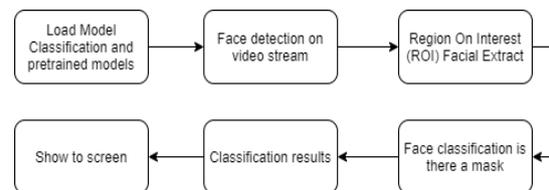
$$F1 \text{ Score} = 2 \times \frac{(\text{Precision} \times \text{Recall})}{(\text{Precision} + \text{Recall})} = \frac{2TP}{2TP + FP + FN} \quad (5)$$

#### g. Implementation

Implementation is the stage carried out to assemble the entire system components. The hardware components are then assembled so that they can be integrated into the flow as shown in Figure 9.

**Figure 10. Hardware circuit diagram**

Furthermore, after the model training process was carried out, the research produced a model with the extension \*.model with the h5 storage format. The model is then stored in the internal storage space on the microcontroller. Based on the experiments in the previous training, the model that has the most optimal performance is the model using the 2nd dataset. This model will be used by the microcontroller during the mask classification process for users. The working process of the system in classifying masks can be seen in the following picture

**Figure 11. The working process of classifying masks on the system**

Several processes are carried out to classify the use of masks through video data captured by the camera. The model file that has been created in the training process along with the pre-trained model provided by OpenCV is entered into the system, which then the system will get a data stream in the form of image frames through the camera. From the image frame obtained, the model will extract the Region of Interest (ROI) to get user face data to be classified. This ROI data will later be included in the mask classification model. The results of the detection of the user's facial area will be displayed in the form of a boundary box with a percentage of classification accuracy. The results of the classification with the model can be seen in Figure 11.

### 3. Result

Automated gate system development results in embedded devices that are fully integrated between every hardware and software component. In addition, the gate system has a user interface consisting of several features such as home and sensor calibration which can be observed in Figure 12.

**Figure 12. Example of model classification results**

In addition, there is the development of mobile applications that are used to control certain conditions. The mobile application was developed using a mobile multiplatform framework, Flutter [30]. The selection of Flutter is considered more effective and efficient for developing mobile applications on several platforms at once. Flutter uses the Dart programming language as the main programming language. The development of a mobile application on this gate system has several features such as calibration and direct gate control through relay activation, as can be seen in Figure 13. The results of the gate system development that have been carried out are then evaluated through several test components, namely sensor testing, classification model testing, and system performance testing. In addition, there are also model training results that are considered to obtain the best model to be implemented in the gate system.



Figure 13. System application user interface

Sensor testing used in this study consisted of the MLX90614 temperature sensor and the HC-SR04 ultrasonic sensor. Sensor testing is done by comparing the results of temperature measurements with standard measuring instruments, in this case, the temperature sensor will be compared with a thermogenic and ultrasonic sensor compared with a ruler. The test experiment was carried out 10 times and the sensor accuracy results were shown in Table 6.

Based on the test data of the MLX90614 temperature sensor and the HC-SR04 ultrasonic sensor, the sensor accuracy rate is very good, reaching 99%. The use of temperature sensors MLX90614 and HC-SR04 can also generally work well with minimum standards equivalent to standard measuring instruments.

Table 6. Sensor test results

Test	MLX90614	HC-SR04
1	98.87%	98.90%
2	99.77%	99.82%
3	99.74%	99.50%
4	99.57%	99.85%
5	99.95%	100.00%
6	98.54%	97.53%
7	97.72%	100.00%
8	99.46%	99.94%
9	99.40%	99.50%
10	98.54%	99.53%
$\bar{x}$	99.16%	99.45%

Testing the mask classification model is done by looking at the results of the confusion matrix obtained after training the classification model. The confusion matrix obtained in the training process can be observed in Figure 15.

In the confusion matrix shown in Figure 15, a classification report can be calculated during model training and testing the model's ability to classify different types of masks. The results of the classification report for the mask classification model showed the highest results in the first and second datasets. The results of performance measurement on the classification can be observed in Table 7.

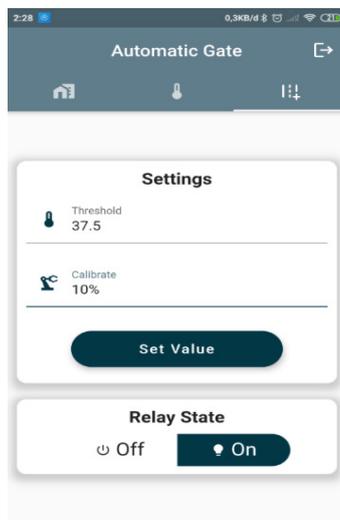


Figure 14. Mobile application user interface

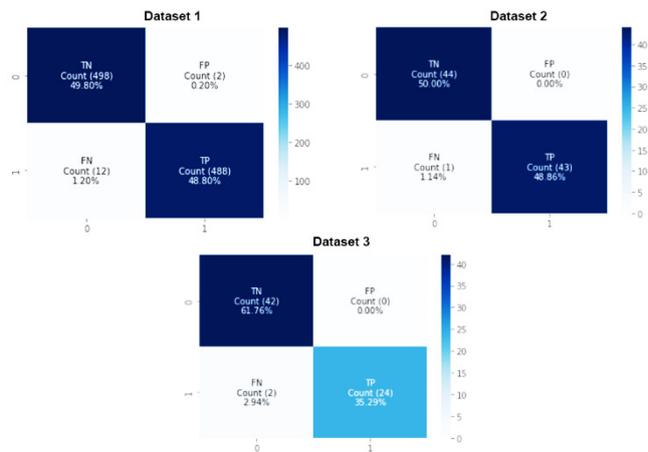


Figure 15. Confusion matrix training

**Table 7. Classification Report model training**

Dataset to-	Class	Precision	Recall	F1-Score
1	with_mask	0.98	1.00	0.99
	without_mask	1.00	0.98	0.99
2	with_mask	0.98	1.00	0.99
	without_mask	1.00	0.98	0.99
3	with_mask	0.95	1.00	0.99
	without_mask	1.00	0.92	0.99

To choose the best face mask classification model, it is necessary to test the success of the model in classifying the variance of masks. The percentage of success of the classification model shows that the model with the second dataset excels with a value of 80% compared to the first dataset by 40% and the third dataset by 20%. Thus, the model that will be used is a model that is trained using the second dataset. In addition, the selected model will also be tested on various types of masks circulating in the community. The test results for the variation of masks can be seen in Table 8.

Tests were carried out to see the model's performance in recognizing mask variations, carried out on 15 variations of masks, and obtained an average accuracy of 99.63%. This shows that in general, the classification model can recognize masks that are generally used by the public

Evaluation of response time or system operating time also needs to be considered to find out how fast the system works to take into account the possibility of queues. Evaluation of response time is done by testing 10 times. The results of the response time test can be observed in Table 9.

Based on the results of the response time test, the classification of masks has the largest response time, this is because the classification process requires a fairly high resource. The total time in general for the system to work is 19.8 seconds, which is quite fast compared to manual testing by officers.

**Table 8. The results of model testing on variations of masks**

No	Mask Type	Motive	Accuracy	Status
1	Medical Mask	Blue color	99.98%	Succeed
2	Medical Mask	Grey color	99.81%	Succeed
3	Medical Mask	Green color	99.83%	Succeed
4	N95 Mask	White color	99.89%	Succeed
5	Cloth Mask	Dark green color	99.75%	Succeed
6	Cloth Mask	Light green color	99.96%	Succeed
7	Cloth Mask	Brown color	98.90%	Succeed

No	Mask Type	Motive	Accuracy	Status
8	Cloth Mask	Grey color	99.91%	Succeed
9	Cloth Mask	Black color	99.31%	Succeed
10	Cloth Mask	Purple color	99,90%	Succeed
11	Cloth Mask	Landscape painting pictures	99.70%	Succeed
12	Cloth Mask	Bear pictures	98.47%	Succeed
13	Cloth Mask	Batik pictures	99.99%	Succeed
14	Cloth Mask	Smile pictures	90,78%	Succeed
15	Cloth Mask	Smile pictures	99,55%	Succeed
16	No Mask	-	99.86%	Succeed
Average ( $\bar{x}$ )			99.63%	Succeed

**Table 9. Response time test results**

Feature	Average time
Temperature	4 second
Face mask	11.4 second
Object	2.7 second
Gate Activation	5 second
<b>Total</b>	<b>19.8 second</b>

#### 4. Conclusion

Research results suggest that the automatic gate entrance system works well as expected. It checks body temperature accurately and quickly. It enforces the compliance of wearing masks. The gate system that uses the MLX90614 sensor is accurate enough to measure the body temperature without contact. The classification model using MobileNetV2 can classify the wearing of masks with an accuracy of 99.63%. In addition, the average working time of the system is 19.8 seconds per person which is fast enough to overcome the possibility of queues at the gate.

#### Acknowledgment

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# Academic Information System Assessment of AKRB Yogyakarta Using UTAUT

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**Abstract** - Implementation of Academic Information System (AIS) at the Radya Binatama Communication Academy (AKRB) had some problems for some users. That problems are known from interviews with several AIS users. This caused a delay in data exchange with other divisions. This study aims to assess the implementation of AIS to the AKRB by using the Unified Theory of Acceptance and Use of Technology (UTAUT) method. UTAUT has four main constructs that affect user acceptance namely performance expectations, effort expectations, social influences, and facilitating conditions. The data were obtained from distributing questionnaires to all AIS users as many as 40 respondents. Then the data is processed using Structural Equation Modeling (SEM) techniques with the help of SmartPLS. The results of the analysis show that only construct facilitating conditions is valid with a t-statistic value of 2.733. While the other three constructs have values that are in the range of invalid values between -1.96 to 1.96 with the values of each construct being 1.891, 0.050, 1.440. It can be concluded that the application of SIA in AKRB has not been well received by all AIS users. Therefore, it is necessary to conduct an evaluation that represents the other three constructs.

**Keywords:** academic information system, UTAUT, SEM, Smart PLS

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## 1. Introduction

Academic activities are an important part of educational institutions which include student data, starting from registration, tuition fees, to graduation. Academic Information System (AIS) used to store data and manage online academic activities. AIS aims to process all live information in an integrated manner so that the existed data is always real time and up to date [1]. With AIS, academic data management can be done easily and quickly as an information center and used to monitor the progress of student studies.

Radya Binatama Communication Academy (AKRB) Yogyakarta, Indonesia has been using AIS to assist in the implementation of academic activities since 2018 to replace the previous one to carry out a lecture contract using a paper form filled out by students and submitted to the university. Every system used, of course, requires changes in line with user needs. The use of AIS is intended to improve services to students and make it easier for academic staff in the operator section to carry out routine reporting to the government.

Since the implementation of AIS at the AKRB in 2018, there has never been a test on its implementation. Based on interviews, it is known that there are still staff who do not fully understand how to use AIS. However, the campus management did not know this and did not carry out full socialization regarding the use of AIS. This is deemed necessary considering that the training on the use of this information system is only conducted once and has not been followed by all staff. In addition, there have been several recruitments of new staff who directly use AIS without any detailed instructions regarding its use. This happened caused by AIS users less in optimization of AIS. The effect is that the completion of the work takes time and the flow of information between divisions or to students is hampered. The worst thing that might happen is that the data provided is wrong and results in wrong decision making.

User acceptance greatly affects the application of a technology or system. The extent to which users can utilize and accept the technology is important to know the success rate. This is as done by Widiyanti [2] and Ekayanti [3] who conducted an evaluation to determine

the acceptance of AIS UNISRI Surakarta and LMS Gandhi Memorial Intercontinental School.

The system can be accepted if the user feels the benefits in its use such as helping to complete work quickly and simplifying the work [4]. User acceptance is an important factor to determine the success of the application of system information. An analytical model is needed to measure the level of success of the application of system information, one of which is The Unified Theory of Acceptance and Use Technology (UTAUT) which in this study was chosen to evaluate the implementation of AIS AKRB.

## 2. Methods

### a. Unified Theory of Acceptance and Use Technology (UTAUT)

UTAUT is a theory used to determine the level of user acceptance of an information system. The UTAUT model is a theory developed by Venkatesh, et.al in 2003 [5]. UTAUT combines the successful features of eight leading technology acceptance theories into one theory. The eight leading theories that are combined in UTAUT are Model of PC Utilization (MPTU), the Theory of Reasoned Action (TRA), Motivational Model (MM), Innovation Diffusion Theory (IDT), Technology Acceptance Model (TAM), Social Cognitive Theory (SCT), Theory of Planned Behavior (TPB) and combined TAM and TPB [6]. UTAUT proved to be more successful than the other eight theories in explaining up to 70% of user variance [7]. There are several studies that have tested the acceptance of technology using the UTAUT method and ensured the effectiveness of this model, including the evaluation of the use of WhatsApp for learning during the COVID-19 period at the University of Zimbabwean [8], factors influencing lecturers' intention to use e-learning in environment hybrid [9], evaluation of the application of MyUMN as an academic information system using UTAUT at Multimedia Nusantara University [10], and the use of UTAUT to understand academics' perceptions of the Online Faculty Development Program [11] leading to learning through online portals. In the prevailing covid-19 situation, countries experienced lockdown, work from home, and online learning has emerged in a big way. From traditional classroom teachers to an online learning environment, the role of academicians has changed drastically. Hence, Faculty Development Programs became an important component in this lockdown period for skill and knowledge up-gradation. This study used a quantitative methodology in which a theoretical model UTAUT was tested using hypotheses to assess the interaction between the study variables, performance expectancy (PE).

The purpose of implementing UTAUT is to assist universities in understanding user reactions to the implementation of new technologies. Initially, UTAUT was developed from the Technology Acceptance Model (TAM) with four main constructs that influence it or Behavioral Intention (BI), namely Facilitating Conditions (FC), Social Influence (SI), Effort Expectancy (EE), and Performance Expectancy (PE) as can be seen in Figure 1.

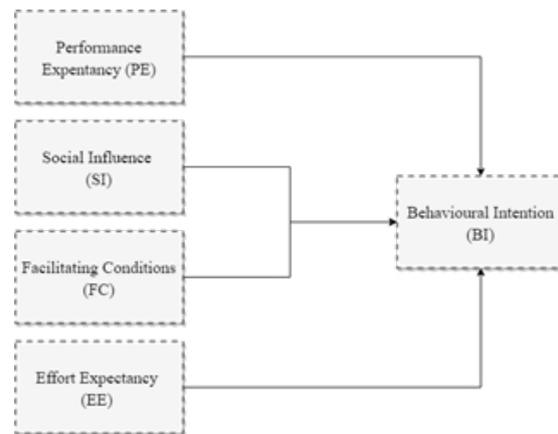


Figure 1. UTAUT Schema

PE is the level of expectation that each individual has that the use of the system can improve performance at work. SI is defined as the extent to which a person perceives the importance that other people believe will influence using the new system. EE is defined as where the comfort of the user in using the system. FC represents the degree to which a person believes that technical infrastructure and the organizational is in place to support the system. Behavioral intention is a behavior of using a technology in the long term, the ability of an application to provide benefits to its users and foster satisfaction for its users so that they want to convey positive things to others and recommend the application to other users and continue to use the application.

A similar study was conducted by Handayani and Sudiana in 2017 [12] including institutions of higher education. With the presence of Academic information systems (SiAkad, by examining the application of the Academic Information System at STTNAS Yogyakarta using the UTAUT method. The study used 325 respondents consisting of lecturers, staffs, and employees. This study also uses four constructs as instruments in the study. The difference lies in Handayani and Sudiana who use SPSS Amos and this study uses Smart PLS as the respondent's data processor. From the results of the analysis, it was concluded that PE, SI, and FC had a significant effect on BI, while the EE variable gave results insignificant. From this research, this study will test the four constructs of the UTAUT model with the following hypotheses:

- H1: EE has an important influence on BI
- H2: FC has an important influence on BI
- H3: PE has an important influence on BI
- H4: SI has an important influence on BI

In facilitating the research process, in this phase, the research phase is divided into several parts.

- a) Introduction. There are several activities carried out, including determining the location of the research, determining the object of research, and setting the title of the research. The research location was determined, namely the AKRB with the object of research focusing on AIS.

- b) Data Collection. There are four stages, namely literature study, observation and interviews, making questionnaires, and distributing questionnaires.
- c) The last step is to analyze the data that has been collected with Smart PLS. The analysis stages are grouped into several parts including testing the outer model and testing the inner model.

#### b. Academic Information System (AIS)

Academic Information System (AIS) is a system built to process campus data with the help of hardware and software so that the stages of academic activities can be analyzed into useful data. The data from the analysis is expected to help manage information and can be used as a reference for policy makers in making decisions for university development. With the existence of SIA, people from inside and outside the university are expected to receive more effective and better information services through the internet so that the education process is carried out properly. Educational institutions generally have many needs and have academic management regulations that are quite complicated and take time, thought and energy. Therefore, AIS is applied to provide a fast, effective and efficient response to the needs and problems of universities to process university data.

### 3. Structural Equation Modeling (SEM)

Structural Equation Modeling (SEM) is a technique developed to analyze many variables so that the limitations of the analytical models used in the past are covered and this technique has also been used in many statistical studies. The advantages of SEM in research include:

- a) Can test the relationship of causality, validity, and reliability at the same time.
- b) Can be used to see the direct and indirect effects between variables.
- c) Testing several dependent variables at once with several independent variables.
- d) Can measure how much the indicator variables affect the respective factor variables.
- e) Can measure factor variables that cannot be measured directly through the indicator variables.

SEM modeling steps start from theoretical model development, path diagram development, flowchart conversion into SEM equations, input matrix selection and estimation techniques, assessing problem identification, model evaluation to interpretation, and model modification[13].

The analysis stage begins with forming an initial model of each method using the adapted constructs. After that, enter the testing stage, Outer Model first which is to test the convergent validity of each indicator of the construct. Validity testing is useful so that all research indicators measuring research variables that have been distributed are valid or not. In SmartPLS, convergent validity is seen through the results of the loading factor of all indicators in the construct related. If the standard

value of the correlation coefficient is 0.5 or more then the data is declared valid. If all indicators of each construct are valid, then the test continues, Outer Model second phase is namely the Discriminant Validity Test.

Discriminant Validity Test reviewed through the indicator value Fornell-Larcker Criterion. A construct is said to be valid if the calculation value indicated by the correlation value between one construct and another is smaller than the Fornell-Larcker Criterion of each construct. If the test results show an invalid value, the test model must be changed again and testing is carried out from the beginning, namely testing convergent validity.

The final testing stage of the Outer Model is the Reliability Test. This testing phase is carried out to see the level of reliability or consistency of a research instrument. To test the reliability of the instrument, technique can be used Cronbach's Alpha and composite reliability. The reliability test is declared valid if it produces Cronbach's Alpha 0.6 and composite reliability 0.7. In this study, the test was carried out with only one measurement or one shot.

After testing the Outer Model has been valid, then the testing can be done Inner Model. This analysis is carried out so that the structural model made is strong and accurate. The stages inner model tests the significance of the effect of each variable by looking at the t-statistical value[14]. The prediction model of the research is said to be good if the r-square value is high. The results of path coefficients represent the level of significance at the hypothesis testing stage. The results of the analysis at this stage are used to review the impact of the independent variable on the dependent variable.

Still in the Inner Model Test, the next test is Hypothesis Testing. At this stage, the focus is on the magnitude of the T-statistic value using a significance level of 95%. The result of the T-table with this number is 1.96. If the results of the T-table are in the range of -1.96 to 1.96, then the hypothesis is rejected or said to be invalid[15]. In SmartPLS there is a bootstrap feature that can be used to get the t-value and path coefficient.

There are several ways to use SEM analysis. The first way is-based SEM Covariance (CB-SEM) which is generally practiced by adopting software packages such as Lisrel, EQS, AMOS, and Mplus. Another way is Partial Least Squares (PLS), which targets analysis of variance and can be done using Visual PLS, PLS-Graph and SmartPLS. In this study, Smart PLS is the choice in analyzing the data to be studied.

### 3. Result

#### a. Respondent

This research is similar to Sani and Salim [16] which only takes respondents from academic staff because the system between staff and students is a different system. Compared with Kristiawan and Harisno's research[10], the study used 423 respondent data distributed via email to AIS users, in this case students. Kristiawan and Harisno's

research processes the respondent's data with different software from the one used in this study. The study used AMOS version 23 for windows but still used the SEM flow in its research. The results of this study indicate that the constructs of Performance Expectancy and Social Influence have a significant impact on the construct of Behavioral Intention.

Another research that is still related to this research is Ulfa's research[17]. Ulfa conducted research with the same object as this research, namely AIS and processed it with the same software, namely SmartPLS. The difference lies in the model used in the analysis. Ulfa's research uses the method DeLone and McLeanand shows the results that the application of AIS has been well received by its users. The constructs that have a significant impact on the implementation of SIMAK are information quality, service quality, system quality, self-efficacy, top management support, user satisfaction, and net benefits. Ulfa's research used 147 respondents data collected from questionnaires via email.

There are 60 respondents used in this research. The characteristics of respondents assessed in this research were age, gender, education, and knowledge of AIS AKRB. Details of the characteristics of 40 respondents can be seen in Table 1. The majority of respondents came from the male group of 26 people. In terms of age 30-39 as many as 17 people. In terms of education, the majority of respondents passed graduate.

**Table 1. Respondent characteristics**

Characteristics	Category	Total
Gender	Man	26
	Woman	14
Age	20-29	4
	30-39	17
	40-49	15
	50-59	4
Education	High School	2
	Diploma	4
	Bachelor	9
	Graduate	25

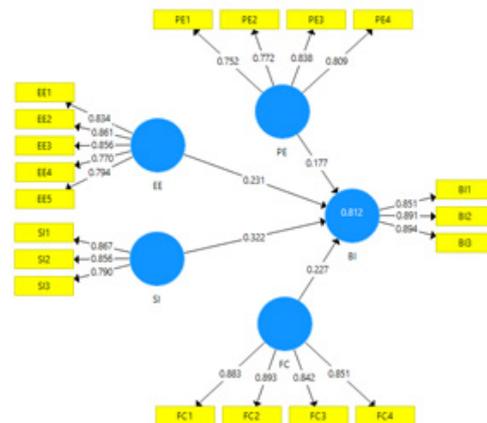
The method for collecting data is using a questionnaire which is a set of questions used to obtain information from respondents related to their personality and other matters related to the research material [18]. Questionnaire distribution is done by distributing questionnaires directly to respondents and using Google Form.

**b. Outer Model Test**

Partial Least Square (PLS) becomes the method used in conducting the analysis and then the data is processed with SmartPLS. PLS is a prophetic method that allows to analyze various independent variables, although there

is a close correlation between two or more independent variables on these variables [11]. PLS is a method similar to SEM with the use of finding solutions to problems in fairly complex variable relationships.

- a) Convergent Validity Test. Validity testing is carried out so that all research indicators measuring research variables that have been distributed are valid or not. In PLS, convergent validity is seen through the results of factor loading of all indicators in the related construct. If the standard value of the correlation coefficient is 0.5 or more then the data is declared valid.



**Figure 2. UTAUT Model first step**

In Figure 2, it can be seen that the loading factor of each instrument is above 0.5 which indicates that the value of all instruments is valid. The next validity test is to test convergence by paying attention to the Average Variance Extracted (AVE) value of each instrument. In Table 2, it can be seen that the AVE value of each indicator of this model is worth more than 0.5 so that the indicators used have reached the minimum standard of convergent validity test.

**Table 2 AVE Value of UTAUT First Step**

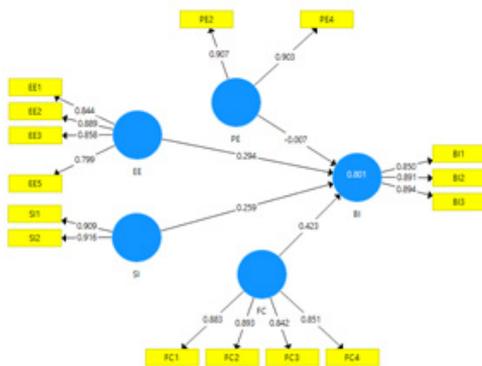
Construct	AVE	Validity
BI	0.772	Valid
EE	0.687	Valid
FC	0.752	Valid
PE	0.629	Valid
SI	0.703	Valid

- b) Discriminant Validity Test. Discriminant Validity testing is reviewed through the Fornell Larcker Criterion value. It is said to be valid if the calculation value indicated by the correlation value between one construct and another is smaller than the Fornell-Larcker Criterion of each construct. Results of testing discriminant validity in this research model can be seen in Table 3.

**Table 3. Fornel Larcker Value UTAUT First Step**

Construct	BI	EE	FC	PE	SI
BI	0.879				
EE	0.844	0.824			
FC	0.840	0.813	0.867		
PE	0.852	<b>0.860</b>	<b>0.912</b>	0.793	
SI	0.854	<b>0.856</b>	<b>0.819</b>	<b>0.834</b>	0.838

Table 3 contains several invalid Fornell-Larcker Criterion values. Therefore, the existing UTAUT model must be modified so that the discriminant validity test is met. The results of the modification of the UTAUT model are shown in Figure 3.



**Figure 3 UTAUT Model Step 2**

From this modified UTAUT model, a convergent validity test is carried out again to ensure that this model has met the specified valid requirements. The loading factor value of each instrument > 0.5 indicates a valid instrument such as the AVE value of this modified model in Table 4.

**Table 4 AVE Value of UTAUT Model First Step**

Construct	AVE	Validity
BI	0.772	Valid
EE	0.719	Valid
FC	0.752	Valid
PE	0.819	Valid
SI	0.833	Valid

At Table 4 shows that the AVE value of each construct shows a value > 0.5 so that all constructs used in this study are valid. Next is to re-test Discriminant Validity by comparing the Fornell Larcker Criterion value of each construct against the construct itself with the Fornell Larcker Criterion value of other constructs. The Fornell Larcker Criterion value of this second model can be seen in Table 5. the Fornell Larcker Criterion value has met the specified assessment value so that this model is valid and can be continued in the analysis to the next step.

**Table 5. Fornel Larcker Value UTAUT step 2**

Construct	BI	EE	FC	PE	SI
BI	<b>0.879</b>				
EE	0.838	<b>0.848</b>			
FC	0.840	0.813	<b>0.867</b>		
PE	0.757	0.762	0.824	<b>0.905</b>	
SI	0.787	0.794	0.710	0.737	0.912

c) Reliability Test. This testing phase is carried out to see the level of reliability or consistency of the research instrument. To test the reliability of the instrument, Cronbach's Alpha and Composite Reliability (CR) techniques can be used. The reliability test is said to be reliable if Cronbach's Alpha 0.6 and CR 0.7. In this study, the test was carried out in one measurement or one shot. The results of the calculation of the reliability value can be seen in Table 6 which shows Cronbach's Alpha for all constructs > 0.60 and CR > 0.7. From this value, it can be said that all constructs have valid reliability.

**Table 6. Alpha Cronbach UTAUT Step 2**

Construct	Cronbach's Alpha	Composite Reliability
BI	0.852	0.910
EE	0.881	0.913
FC	0.890	0.924
PE	0.803	0.872
SI	0.787	0.876

**c. Inner Model Test**

Next step if the outer test phase the model has been fulfilled, namely to test the validity of structural models. This analysis is carried out so that the structural model made is strong and accurate. The inner model stage tests the significance of the effect of each variable by looking at the t-statistics or t-value [14]. The prediction model of the research is said to be good if the r-square value is high. The path coefficient results represent the significance grade at the hypothesis testing step.

- a) Determination Test. The results of the analysis at this stage are used to see the effect of the independent variable on the dependent variable. The r-square value of this model is BI of 0.801. Based on this value, it is concluded that the other four constructs have an influence on BI of 81%, while the remaining 19% are influenced by other constructs not tested in this research. Value of 81% is very high when compared to the research of Handayani and Sudiana [12] including institutions of higher education. With the presence of Academic information systems (SiAkad which only produces a value of 37.6%.
- b) Hypothesis Test. Testing at this stage is focused on the magnitude of the T-statistic value using a significance level of 95%. The result of the T-table with this

number is 1.96. If the results of the T-table are in the range of -1.96 to 1.96, then the hypothesis is rejected or said to be invalid. In Smartpls there is a bootstrap feature that can be used to get the t-value and path coefficient. Based on Table 7, it can be seen that the significance of the relationship between variables is by comparing the path coefficient value with the results on the T-Statistic.

**Table 7. Mean and T Statistic Value of UTAUT Step 2**

	Path Coefficient	STDEV	T-Statistic
EE -> BI	0.294	0.155	1.891
FC -> BI	0.432	0.155	<b>2.733</b>
PE -> BI	-0.007	0.139	0.050
SI -> BI	0.259	0.180	1.440

From Table 7, it can be seen that one hypothesis can be accepted and the other hypotheses are rejected.

H1: The T-Statistic value of 1.891 means that EE does not have a significant effect on BI. The path coefficient value of 0.294 indicates that the EE construct gives a positive correlation value to the BI construct.

H2: With a T-Statistic value of 2,733, it means that FC has a significant influence on BI. The path coefficient value of 0.432 indicates that the FC construct gives a positive correlation value to the BI construct.

H3: With a T-Statistic value of 0.050, it means that PE does not have a significant effect on BI. The path coefficient value -0.007 indicates that the PE construct gives a negative correlation value to the BI construct.

H4: The T-Statistic value of 1,440 means that SI does not have a significant influence on BI. The path coefficient value of 0.259 indicates that the SI construct provides a positive correlation value to the BI construct.

#### 4. Conclusion

The results of the analysis of the application of AIS to AKRB using the UTAUT model show that of the four hypotheses tested, only 1 hypothesis is valid or accepted. The construct is a Facilitating Condition (FC) with a T-Statistic value of 2.733.

Based on these values, it is concluded that the implementation of AIS on the AKRB Campus is still not good. This is indicated by the presence of three constructs that are still invalid, namely Performance Expectancy (PE), Effort Expectancy (EE) and Social Influence (SI). The results of the analysis using the UTAUT model can be used as recommendations to the AKRB in making policies as needed. For example, The PE construct representing user beliefs regarding the ease provided from using AIS is still rejected. As well as with SI which describes the influence of the environment in using AIS. It is necessary to hold socialization or training from the Campus to new users, and if there is an update in AIS. The EE construct

relates to the user interface of AIS, which means that it is necessary to evaluate and improve AIS. Future research are expected to be able to use other methods in conducting research or examining other objects in the AKRB such as AIS for students.

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# Combination of Support Vector Machine and Lexicon-Based Algorithm in Twitter Sentiment Analysis

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**Abstract** - Data from the Ministry of Civil Works and Public Housing (Kementrian PUPR) in 2019 shows that around 81 million millennials do not own houses. Government Regulation Number 25 of 2020 on the Implementation of Public Housing Savings, commonly called PP 25 Tapera 2020, is one of the government's efforts to ensure that Indonesian people can afford houses. Tapera is a deposit of workers for house financing, which is refundable after the term expires. Immediately after enactment, there were many public responses regarding the ordinance. We investigate public sentiments commenting on the regulation and use Support Vector Machine (SVM) in the study since it has a good level of accuracy. It also requires labels and training data. To speed up labeling, we use the lexicon-based method. The issue in the lexicon-based lies in the dictionary component as the most significant factor. Therefore, it is possible to update the dictionary automatically by combining lexicon-based and SVM. The SVM approach can contribute to lexicon-based, and lexicon-based can help label datasets on SVM to produce good accuracy. The research begins with collecting data from Twitter, preprocessing raw and unstructured data into ready-to-use data, labeling the data with lexicon-based, weighting with TF-IDF, processing using SVM, and evaluating algorithm performance model with a confusion matrix. The results showed that the combination of lexicon-based and SVM worked well. Lexicon-based managed to label 519 tweet data. SVM managed to get an accuracy value of 81.73% with the RBF kernel function. Another test with a Sigmoid kernel attains the highest precision at 78.68%. The RBF kernel has the highest recall result with a value of 81.73%. Then, the F1-score for both the RBF kernel and Sigmoid is 79.60%.

**Keywords:** sentiment analysis, tapera, public housing, lexicon-based, confusion matrix

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## 1. Introduction

Based on data from the Ministry of Public Works and Public Housing (Kementrian PUPR) in 2019, there were around 81 million millennial generations (or equivalent to 30% of Indonesia's population) who did not own homes [1]. In other data sources, there are about 11 million households (KRT) who have an income below Rp. 8 million who do not own a house and this number is equivalent to 15% of the total 71 million KRT. For the top 10 provinces with the percentage of households who do not own a house, Jakarta is at the top. The illustration is that two out of five households in the capital city do not yet own a house, the percentage is indeed large. Of the 3 million households in Jakarta, 41 percent do not own a house [2].

From this data, the government is trying to make Indonesian people have a place to live. One of them is through the making of Government Regulation Number

25 of 2020 concerning the Implementation of Public Housing Savings or commonly called PP 25 Tapera of 2020. Tapera is a term deposit by workers for housing financing, or it can also be returned after the time expires. The amount of this savings is 3% of the salary received by workers with a division of 0.5% from the employer or in this case the company and 2.5% from the workers themselves [3].

There have been many responses from the public regarding this regulation. Their responses varied, ranging from those who rejected this regulation, those who supported it, or those who were neutral. Twitter social media is one of the media for delivering public feedback regarding the implementation of this regulation. From their responses, the sentiments of the community regarding the implementation of this regulation can be seen. It takes a suitable research model for sentiment analysis, such as using Naïve Bayes, Support Vector Machine (SVM), KNN, and so on. From several sentiment analysis studies,

the algorithm that has a better level is the Support Vector Machine (SVM) [4].

SVM has better results as evidenced in several previous studies, including research on Sentiment Analysis on Tourism Objects in Central Java. The results of this study conclude that SVM has a higher accuracy result of approximately 10% than Naïve Bayes [5]. Other research on Comparative Analysis of Accuracy and Processing Time in SVM and KNN Algorithms shows SVM is slightly superior in accuracy compared to KNN [6]. Based on the research examples above, SVM has good accuracy results in the sentiment analysis process. However, the implementation of SVM in addition to requiring training data also requires labels and usually the data to be tested is data in large quantities so manual labeling will take a long time [7].

Based on the previous explanation, there needs to be a method to label, using opinion words or sentiment words, which words express a positive sentiment or negative sentiment. One of the labeling methods that can be used is the lexicon-based method. Lexicon-based is a method to be able to determine sentiment or polarity of opinion through several functions of opinion words in documents or sentences based on the lexicon dictionary [8]. Dictionaries are an important component in systems that use lexicon-based methods. The difficulty that occurs in the lexicon-based method lies in determining or updating the dictionary by humans. For that, it can be done by updating the dictionary automatically by combining lexicon-based with machine learning [9].

The above notion becomes the basis for the formation of a combination of SVM and lexicon-based. SVM approach can contribute to lexicon-based methods, and lexicon-based can help label datasets in SVM. This combination is carried out sequentially, using lexicon-based to determine the sentiment value, and the lexicon result data is used as labeling data for the Support Vector Machine. In other words, this combination makes lexicon-based a means to transfer learning to SVM in the hope that the combination of methods and algorithms can contribute to the sentiment labeling process to get good accuracy. [10].

## 2. Method

The research method used to conduct this research is to apply a combination of lexicon-based and support vector machines, where lexicon-based as a data labeling method with sentiment values and labeling results data is used by SVM. The dataset used comes from Twitter regarding the implementation of PP Tapera No. 25 the Year 2020.

Figure 1 shows the stages of the research carried out, including the stages of data collection that produces research datasets, then from the research datasets, preprocessing data is carried out, then followed by the data labeling process with lexicon-based, then the TF-IDF weighting process, processing with SVM, and the last is the evaluation process using the confusion matrix.

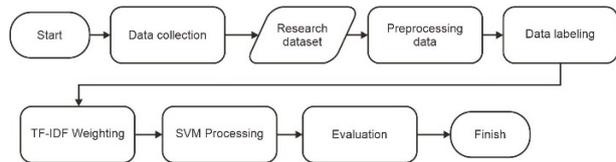


Figure 1. Research Steps

### a. Data collection

The dataset used in this study is a dataset originating from Twitter response regarding PP Tapera No. 25 of 2020. The data collection method used is by using the help of Octoparse tools. After getting the Twitter URL about the dataset, then the URL is entered into octoparse. After entering the URL, next set up the data pagination process which has a function to extract data through different pages. The data extraction process will run and will be completed when the data is considered exhausted. Figure 2 is the dataset that was successfully collected in the data collection process. Later what will be used is only the Tweet column.

User	Date	Tweet
Kementerian PUPR	29-Mar-19	Masa jabatan Komisiner dan Deputi Komisiner ...
Paula	12-Jun-20	Peraturan Pemerintah yang ditandatangani ln@...
Radio PRFM 107,5 News Channel	4-Jun-20	Sampaikan opini dan komentar anda terkait PP T...
detikcom	17-Jun-20	Deputi Komisiner bidang Pemanfaatan Dana BP T...
Titik Terang	5-Jun-20	Kementerian PUPR mengatakan pemerintah ingin m...
...	...	...
Save Palestine	18-Jun-20	Seluruh Pekerja wajib jadi anggota TAPERA... D...
pi	5-Jun-20	Barusan cek lagi, ada batasnya max Rp 12 juta ...
Dr. Rizal Ramli	6-Jun-20	Mulai belajar bikin kebun hidroponik utk 120 ...
???? ???? ?????	6-Jun-20	Klo punya hobi yg menghasilkan income diem' ba...
Ceu Umay	7-Jun-20	Bisa aja yg bikin ginian nih, tp menurut gw em...

Figure 2. Research Dataset

### b. Data Preprocessing

The data that has been obtained, will previously go through a preprocessing process which has the aim of changing data that is still rough, unstructured, and has a lot of noise, into data that is ready to be processed [11] The preprocessing process applied consists of 5 stages which are depicted in Figure 3.

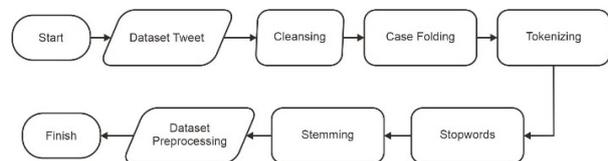


Figure 3. Preprocessing Steps

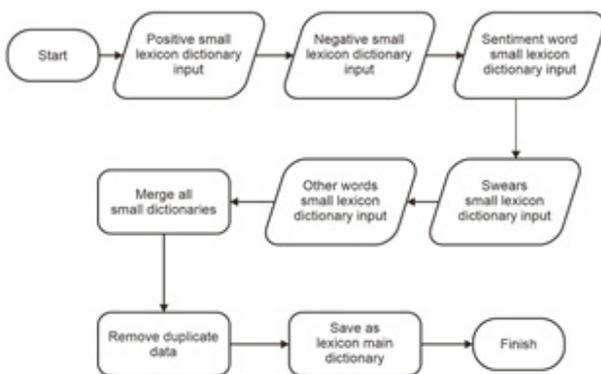
The first preprocessing stage is cleansing, the cleansing stage functions to remove punctuation characters, as well as characters that are not needed. Next is case folding to change the text of various tweet data consisting of lowercase and uppercase letters into all lowercase letters. Next, we have the tokenizing stage to change or break sentences into word-for-word parts. The stopwords stage has a function to remove words that are considered general and have no

meaning. Finally, the stemming stage is to change all the words into the basic form of the word, and the dataset is considered ready to be used for the research process.

**c. Data Labeling**

After performing the data preprocessing process, the next step is the data labeling process. Data labeling is needed to transfer learning to SVM, and since manual data labeling takes a long time, a lexicon-based method is needed. Lexicon-based labeling is a method to determine sentiment or polarity of opinion through several functions of opinion words in documents or sentences [8]. Lexicon-based labeling is used to give positive or negative weight to each word that appears based on the lexicon or a compiled dictionary that stores words with positive and negative sentiments [12].

The lexicon labeling process requires a dictionary as a reference to calculate the polarity of opinion or sentiment. The dictionaries used in this study are compiled based on small dictionaries provided by *evanmertua34's* github repository with links <https://github.com/evanmertua34/Twitter-COVID19-Indonesia-Sentimen-Analysis---Lexicon-Based>. These small dictionaries consist of a small dictionary of positive and negative lexicon from Inset (Indonesia Sentimen Lexicon) belonging to Fajri Koto, and Gemala Y. Rahmaningtyas), then there is a small dictionary of lexicon sentiment words, then there is also a small dictionary of lexicon swear words which contains the words - swear words, as well as other small dictionaries. Later all the small dictionaries will be combined into a main lexicon dictionary for the data labeling process. The stages of making the main lexicon dictionary are described in Figure 4.

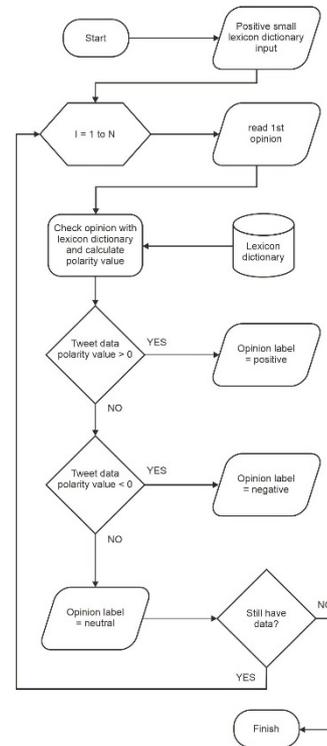


**Figure 4. Making a Lexicon Based Dictionary**

The next step is the process of labeling the dataset with the created lexicon dictionary. The labeling process is done by checking the sentiment words or opinion words contained in each tweet data, then the weight is calculated based on the lexicon dictionary. The results of the calculation of the value/weight of sentiment or opinion words in each tweet data are accumulated to see the results of labeling the tweet data. If the accumulated weight value in each tweet data is more than 0 (> 0), then the tweet is labeled positive. If the accumulated result is less than 0 (<0), the tweet is labeled negative. Meanwhile, a tweet is considered neutral, if the accumulated results are equal to 0. More or less, the equation is as follows [13]:

$$\text{if } \begin{cases} \sum k \text{ Score } (k) > 0 \text{ then positive} \\ \sum k \text{ Score } (k) < 0 \text{ then negative} \\ \sum k \text{ Score } (k) = 0 \text{ then neutral} \end{cases} \quad (1)$$

The data labeling process with the lexicon dictionary is shown in Figure 5.



**Figure 5. Data Labeling Process**

**d. Term Weighting**

After carrying out the data labeling process, the next step is term weighting process with TF-IDF. Because basically the machine can only process numbers, then each word in the document will be given a weight or frequency value, and then the result of this weighting process is a vector value, later the vector value will be entered into a vector space for later use for the testing process algorithm after this [14].

The weighting process with TF-IDF is shown in Figure 6. The dataset that has gone through the data labeling process will then be divided into 80% composition for training, and 20% for testing. The next step is to calculate the TF or Term-Frequency value based on the number of occurrences of each word in the document. Then, calculate the DF or Document-Frequency, which is to calculate the value of the number of documents that have terms, then calculate the value of N to count the entire number of existing documents. Next, calculate the Inverse Document Frequency from DF and N. After the TF and IDF values are obtained, then we do the calculation [15]. The results of this calculation will produce a word weight. The TF-IDF results from the data train will become a learning model using SVM and the learning model is tested by the testing data.

The TF-IDF calculation equation is shown through the equation below:

$$TF = \begin{cases} 1 + \log_{10}(f_{t,d}), & f_{t,d} > 0 \\ 0, & f_{t,d} = 0 \end{cases} \quad (2)$$

$$IDF = \log_{10} \frac{N}{DF_t} \quad (3)$$

$$W_{t,d} = TF \cdot IDF \quad (4)$$

with:

TF = Word weight of each document

$f_{t,d}$  = Number of occurrences of term in document

IDF = Inverse weights in DF documents

DF = Number of documents containing Term

$W_{t,d}$  = TF-IDF Weighting

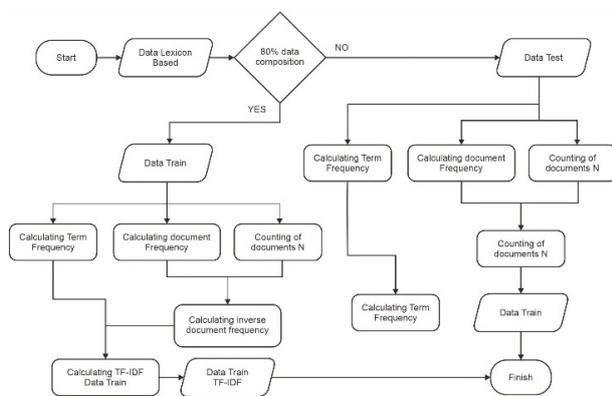


Figure 6. TF-IDF Weighting Steps

**e. SVM Processing**

After going through the weighting process, the next step is to do sentiment analysis with SVM. SVM or Support Vector Machine is one of the algorithms with supervised learning category for data classification needs [16]. The working concept of SVM is to find the best hyperplane that separates two classes in the input space. Maximum Marginal Hyperplane calculation is used to obtain the best hyperplane in separating two classes [17].

The SVM illustration can be seen in the equation as shown in Figure 7.

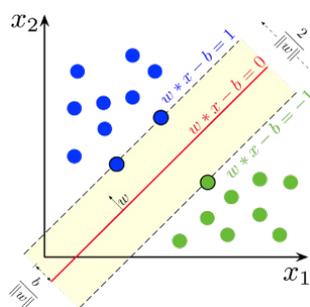


Figure 7. Hyperplane Support Vector Machine [26]

In obtaining the hyperplane, the following equation can be used:

$$(w \cdot x_j + b) = 0 \quad (5)$$

$x_j$  is tuple and is class label with  $i = 1 \dots N$ ,  $x_j \in R^d$  and  $y_j \in \{-1, 1\}$ . The equation is as follows [18]:

$$f(x_j) = \begin{cases} (w \cdot x_j + b) \leq 1, & y_j = -1 \\ (w \cdot x_j + b) \geq 1, & y_j = 1 \end{cases} \quad (6)$$

Although it is explained that the hyperplane separates two classes in the input space, SVM has been developed to be able to overcome the problem of more than two classes or non-linear classifiers by using the kernel trick concept [19]. By using the kernel trick, it can make it easier to solve non-linear problems by entering data in a high-dimensional space [20]. The equations of each SVM kernel function can be seen in Table 1.

Table 1. Kernel Equation

Kernels	Equality
Linear	$K(x_i, x_j) = x_i^T x_j$
RBF	$K(x_i, x_j) = \exp(-\gamma  x_i - x_j ^2), \gamma > 0$
Polynomial	$K(x_i, x_j) = (\gamma \cdot x_i^T x_j + r)^d, \gamma > 0$
Sigmoid	$K(x_i, x_j) = \tanh(\gamma \cdot x_i^T x_j + r)$

Each kernel function in SVM has certain parameters that are used for the testing process in this research. The parameters used are described in Table 2. These parameters are general parameters that are often used. The C value is the most common for all SVM kernels. The gamma parameter ( $\gamma$ ) is used to determine the level of proximity between two points, making it easier to find a hyperplane separator that is consistent with the data. The degree (d) parameter has a function to help map data from the input space to a higher dimension space in the feature space, so that in the new dimension a consistent hyperplane can be found. The parameter coef0 serves as an independent value [21].

Table 2. SVM Kernel Parameters

Kernels	Parameter			
	C	Gamma ( $\gamma$ )	Degree (d)	Coef0
Linear	✓	×	×	×
RBF	✓	✓	×	×
Polynomial	✓	✓	✓	✓
Sigmoid	✓	✓	×	✓

The processing stage with the Support Vector Machine (SVM) in this study is described in Figure 8. The data that has passed the weighting process with TF-IDF, then entering the process of determining the parameters used for each kernel function. Then carry out the process

of testing the data train with kernel functions that already have certain parameters. Testing the data train produces a learning model that is used by the test data. The result of the test data is a model accuracy result of each SVM kernel function.

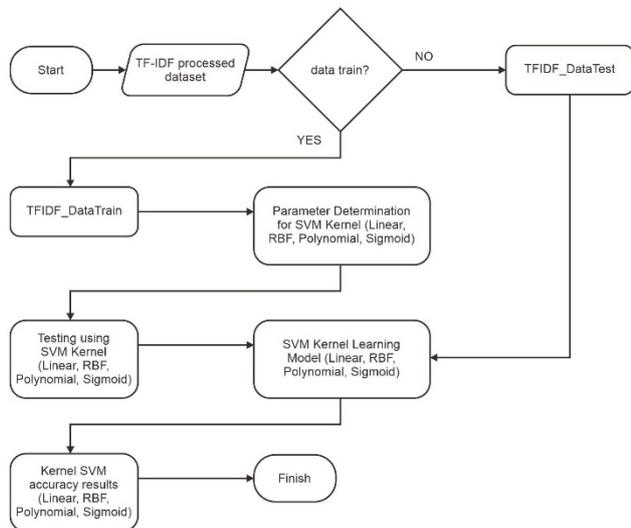


Figure 8. SVM Processing Steps

**f. Evaluation**

The evaluation process is carried out with a confusion matrix to test how well the classification algorithm performance model is built or used [22]. The confusion matrix provides a comparative information between the actual classification results or the actual results and predictions [23]. In general, the confusion matrix has a 2X2 structure for binary classification, which is shown in Table 3.

Table 3. Confusion Matrix 2X2

Actual	Prediction	
	Positive	Negative
Positive	TP (True Positive)	FP (False Positive)
Negative	FN (False Negative)	TN (True Negative)

For non-binary classification needs, it is adjusted to the number of labels or classes used. Because, in this study, the classification of 3 labels or 3 classes consisting of negative, neutral, and positive was applied, the confusion matrix structure is as shown in Table 4.

Table 4. Confusion Matrix 3X3

Actual	Prediction		
	Negative	Neutral	Positive
Negative	TNt (True Negative)	FNe (False Neutral)	FP (False Positive)
Neutral	FNt (False Negative)	TNe (True Neutral)	FP (False Positive)
Positive	FNt (False Negative)	FNe (False Neutral)	TP (True Positive)

The confusion matrix is also the basis for calculating accuracy, precision, recall, and f1-score values from the test. The accuracy value shows the correct prediction results with actual conditions. Precision shows the accuracy or accuracy of the test results. Recall shows the value to measure the proportion of the results of the correct value identified. F1-Score is the result of precision and recall [24]. The formula for determining the values above is shown below:

$$Accuracy = \frac{TP + TN}{TP + FP + TN + FN} \tag{7}$$

$$Precision = \frac{TP}{TP + FP} \tag{8}$$

$$Recall = \frac{TP}{TP + FN} \tag{9}$$

$$F1 - Score = 2 \frac{precision \times recall}{precision + recall} \tag{10}$$

Information:

- TP (True Positive) = Indicates a positive result detected correctly
- TN (True Negative) = Indicates a correctly detected negative result
- FP (False Positive) = Shows negative results detected positive
- FN (False Negative) = Shows positive results detected negative

**3. Result**

The results of the study contain a description of each stage or process carried out in this study.

**a. Data Preprocessing**

The tweet dataset used in this study is unstructured, coarse, and still has a lot of characters that can cause noise. Thus, it is necessary to carry out a data preprocessing process to make the data ready to be processed. The preprocessing stage carried out is the cleansing process to remove punctuation characters, as well as characters that are not needed. The results of the cleansing process can be seen in Table 5.

Table 5. Cleansing Process Results

Before	After
Masa jabatan Komisioner dan Deputy Komisioner Badan Pengelola Tabungan Perumahan Rakyat adalah selama lima tahun sejak ditetapkannya Keputusan Presiden. #BPTapera #Tapera #SejutaRumah #InfrastrukturUntukIndonesiaMaju #PUPRSigapMembangunNegeri	Masa jabatan Komisioner dan Deputy Komisioner Badan Pengelola Tabungan Perumahan Rakyat adalah selama lima tahun sejak ditetapkannya Keputusan Presiden BPTapera Tapera SejutaRumah InfrastrukturUntukIndonesiaMaju PUPRSigapMembangunNegeri

The case folding process stage is performed to change all characters consisting of uppercase and lowercase letters

into whole lowercase letters. The results of case folding can be seen in Table 6.

**Table 6. Case Folding Process Results**

Before	After
Masa jabatan Komisioner dan Deputy Komisioner Badan Pengelola Tabungan Perumahan Rakyat adalah selama lima tahun sejak ditetapkannya Keputusan Presiden BPTapera Tapera SejutaRumah InfrastrukturUntukIndonesiamaju PUPRSigapMembangunNegeri	masa jabatan komisioner dan deputy komisioner badan pengelola tabungan perumahan rakyat adalah selama lima tahun sejak ditetapkannya keputusan presiden bptapera tapera sejutarumah infrastrukturuntukindonesiamaju puprsigapmembangunnegeri

Then, the tokenizing process is carried out to change or break the sentence into word-for-word parts. Table 7 gives the results of the tokenizing process.

**Table 7. Tokenizing Process Results**

Before	After
masa jabatan komisioner dan deputy komisioner badan pengelola tabungan perumahan rakyat adalah selama lima tahun sejak ditetapkannya keputusan presiden bptapera tapera sejutarumah infrastrukturuntukindonesiamaju puprsigapmembangunnegeri	['masa', 'jabatan', 'komisioner', 'dan', 'deputi', 'komisioner', 'badan', 'pengelola', 'tabungan', 'perumahan', 'rakyat', 'adalah', 'selama', 'lima', 'tahun', 'sejak', 'ditetapkannya', 'keputusan', 'presiden', 'bptapera', 'tapera', 'sejutarumah', 'infrastrukturuntukindonesiamaju', 'puprsigapmembangunnegeri']

The next process is the stopwords process. This process serves to remove words that are considered general and have no meaning. The results of stopwords are described in Table 8.

**Table 8. Stopwords Process Results**

Before	After
['masa', 'jabatan', 'komisioner', 'dan', 'deputi', 'komisioner', 'badan', 'pengelola', 'tabungan', 'perumahan', 'rakyat', 'adalah', 'selama', 'lima', 'tahun', 'sejak', 'ditetapkannya', 'keputusan', 'presiden', 'bptapera', 'tapera', 'sejutarumah', 'infrastrukturuntukindonesiamaju', 'puprsigapmembangunnegeri']	['jabatan', 'komisioner', 'deputi', 'komisioner', 'badan', 'pengelola', 'tabungan', 'perumahan', 'rakyat', 'ditetapkannya', 'keputusan', 'presiden', 'bptapera', 'tapera', 'sejutarumah', 'infrastrukturuntukindonesiamaju', 'puprsigapmembangunnegeri']

The final stage is the stemming process to change all the words into the basic form of the word. Or in other cases, stemming will remove the affixes in each word. The results of stemming are shown in Table 9.

**Table 9. Results of the Stemming Process**

Before	After
['jabatan', 'komisioner', 'deputi', 'komisioner', 'badan', 'pengelola', 'tabungan', 'perumahan', 'rakyat', 'ditetapkannya', 'keputusan', 'presiden', 'bptapera', 'tapera', 'sejutarumah', 'infrastrukturuntukindonesiamaju', 'puprsigapmembangunnegeri']	jabat komisioner deputi komisioner badan kelola tabung rumah rakyat tetap putusan presiden bptapera tapera sejutarumah infrastrukturuntukindonesiamaju puprsigapmembangunnegeri

After performing various stages of preprocessing starting from cleaning, case folding, tokenizing, stopwords, and stemming, the preprocessing dataset was obtained. Figure 9 is a dataset resulting from the data preprocessing process. From here, the dataset is ready to be used for the research process.

## b. Data Labeling

The process of labeling or labeling or classing tweets is done using the lexicon-based method. The lexicon-based method in this study was carried out using the main lexicon dictionary which had been compiled from small lexicon dictionaries from evanmertua34's github repository, with the link <https://github.com/evanmartua34/Twitter-COVID19-Indonesia-Sentimen--Lexicon-Based>. The small dictionary consists of a positive inset dictionary, a negative inset dictionary, a sentiment word dictionary, a swear words dictionary, and several other small dictionaries.

**Table 10. Positive Inset Dictionary Example**

Positive Inset Dictionary	
Word	Weight
Thank you	5
Please	2
Sorry	2

The positive inset dictionary consists of words with a weight above 0. Table 10 is an example of some words from the positive inset dictionary. It can be seen that the word 'thank you' has a weight of 5, or the word with the highest weight. Then there is the word 'please' with a weight of 2, and there is the word 'sorry' with a weight of 2.

**Table 11. Negative Inset Dictionary Example**

Negative Inset Dictionary	
Word	Weight
No	-3
Betray	-4
Do not want	-4

The negative inset dictionary consists of words with weights below 0. Table 11 is an example of some words from the negative inset dictionary. The word 'no' has a weight of -3. Then, there is the word 'betray' has a weight of -4, and the word 'don't want to' also has a weight of -4.

**Table 12. Sentiment Word Dictionary Example**

Word Sentiment Dictionary	
Word	Weight
Wonderful	3
Anarchy	-2
Graceful	-4

Sentiment word dictionary consists of sentiment words with a weight range of -5 to 5. Table 12 is an example of some words from the sentiment word dictionary. The word 'wonderful' has a weight of 3. Then, there are the words 'anarchy' and 'graceful' with a weight of -2 and -4 respectively.

**Table 13. Swear Words Dictionary Example**

Swear Words Dictionary	
Word	Weight
Stupid	-5
Curse	-5
Crazy	-5

Swear words dictionary is a small dictionary that contains swear words, so all the words in this dictionary have a weight of -5. It can be seen for example some words in Table 13, that the words 'stupid', 'curse', and 'crazy' have a weight of -5.

The existing small lexicon dictionaries are combined into one and then duplicated to become the main lexicon dictionary which consists of ±10200 words with various weights. The dataset labeling process is carried out by going through the process of calculating sentiment words by calculating them into the lexicon. Then create a dataframe to store the previous bag of words and sentiment word calculations.

**Table 14. Result Dataframe Dataset to Lexicon**

	shake	body	tube	...	key	Spice	Sentiment
0	1	1	1	...	0	0	9
1	0	1	0	...	0	0	21
2	0	0	0	...	0	0	1
3	0	0	0	...	0	0	9
...	...	...	...	...	...	...	...
516	0	0	0	...	1	1	8
517	0	0	0	...	0	0	-7
518	0	0	0	...	0	0	2

519 rows X 634 columns

Table 14 is a dataframe structure created to accommodate the bag of words and the calculation of sentiment words in the dataset to the lexicon. The description "519 rows" indicates the number of tweet datasets that are labeled. Then, 634 is the number of sentiment words in the dataset that are calculated into the lexicon. The sentiment column shows the weight of each tweet data. It can be seen that the 3rd row tweet data has a weight of 9, then the 516th row tweet data has a weight of 8, and the 517th row tweet data has a weight of -7.

The results of all tweet datasets are given their respective weights, then converted into 3 main label forms. Tweets with a weight above 0, will be changed to label 1 or positive. Tweets with a weight below 0, are changed to the label -1 or negative. And, tweets with a weight equal to 0, are changed to 0 or neutral labels.

**Table 15. Tweet Labels**

Tweet Weight	Tweet Labels	Label Description	Total
Above 0 (> 0)	1	Positif	370
Under 0 (<0)	-1	Negatif	127
Equal 0 (=0)	0	Netral	22
<b>Total Dataset</b>			<b>519</b>

Table 15 shows the final results of the lexicon-based data labeling that has been used. It can be seen that, out of 519 datasets, 370 data have a positive label or 1. 127 data have a negative label or -1. And 22 data has a neutral label or 0. With this, the data labeling process has been successful and the labeling data can be used by SVM.

**c. Term Weighting**

The weighting is done after the data already has a label. The weighting process with TF-IDF serves to get a vector value from the dataset, later the vector value will be entered into a vector space for later use for the algorithm testing process.

The dataset that has gone through the labeling process is then divided into train data and test data with a composition of 80% versus 20%. Then, the train data and test data are carried out by the TF-IDF weighting process. The results of the TF-IDF train data and test data are described in Table 16 and Table 17.

In Table 16, the tweet column contains as many rows as the number of data in the data train. In other words, shows the index of each data. Then the term column contains the index of the feature word generated from the bag of words. The weight column contains the weight of each generated term. So, how to read from Table 16 is the data at index 0 which contains the 1811th term with the term weight 0.281070643.

In Table 17, the tweet column contains as many rows as the index of each data in the test data. Then the term column contains the index of the feature word generated

from the bag of words. The weight column contains the weight of each generated term. So, how to read from Table 17 is the data at index 0 which contains the 1777 term with a term weight of 0.480879633.

The TF-IDF results from the data train in the form of vector space will become a learning model and will be tested by data testing to find out how well the learning model is.

**Table 16. TF-IDF Data Train Results**

Tweet	Term	Weight
0	1811	0.281070643
0	1763	0.232067791
0	1728	0.571941689
0	1713	0.232067791
0	1650	0.040252079
0	1635	0.173988977
⋮	⋮	⋮
414	266	0.284576677
414	233	0.167824591
414	175	0.294715495
414	119	0.275891625
414	52	0.356111407

**Table 17. TF-IDF Data Test Results**

Tweet	Term	Weight
0	1777	0.480879633
0	1650	0.052862833
0	1429	0.192178494
0	1156	0.290528875
0	1108	0.32484981
0	1008	0.279480002
103	642	0.119453367
103	482	0.240375508
103	235	0.319535955
103	155	0.294302118
103	121	0.356111407

#### d. SVM Processing

Processing using the Support Vector Machine (SVM) focuses on the use of four kernel functions commonly used in SVM, namely the Linear Kernel, Radial Basis Function (RBF) Kernel, Polynomial Kernel, and Sigmoid Kernel.

The parameters used in the testing process are adjusted to the needs of each kernel. These parameters will determine the results of the tests in each kernel. Therefore, the hyperparameter tuning process is carried out using the grid search method to determine the optimal hyperparameter. After the input hyperparameter values are initialized, the grid search will train several prediction models that are formed through each combination of

hyperparameter values. The parameter pair that produces the best accuracy obtained is the optimal parameter [25].

Parameter testing on the kernel is done by assigning a value to each parameter used, namely degree, complexity or C, gamma, coef0, and maximum iteration or max iter. Table 18 describes the input values for the hyperparameter tuning process in each kernel.

**Table 18. Input Hyperparameter Value**

Kernels	Parameter	Value
Linear	C	0.001, 0.01, 0.1, 1, 1.5, 2, 2.5, 10, 20, 100
	Max Iteration	0.001, 0.01, 0.1, 1, 1.5, 2, 2.5, 10, 20, 100
	C	0.001, 0.01, 0.1, 1, 1.5, 2, 2.5, 10, 20, 100
RBF	Gamma	0.01, 0.1, 0.5, 1, 10, 20, 40, 50, 100, 1000
	C	0.001, 0.01, 0.1, 1, 1.5, 2, 2.5, 10, 20, 100
Polynomial	Degree	0.01, 0.1, 0.5, 1, 10, 20, 40, 50, 100, 1000
	Gamma	0.01, 0.1, 0.5, 1, 10, 20, 40, 50, 100, 1000
	Coef0	0.001, 0.01, 0.0, 1, 10
Sigmoid	C	0.001, 0.01, 0.1, 1, 1.5, 2, 2.5, 10, 20, 100
	Gamma	0.01, 0.1, 0.5, 1, 10, 20, 40, 50, 100, 1000
	Coef0	0.001, 0.01, 0.0, 1, 10

After initializing the input values for each hyperparameter, then testing it using a grid search to get the most optimal combination of parameters. Table 19 is the result of the combination of the best hyperparameter values in each kernel by testing it against the train data.

**Table 19. Best Hyperparameter Value for Each Kernel**

Kernels	Parameter				
	C	Max Iter	Gamma	Degree	Coef0
1 Linear	2.5	100	×	×	×
2 RBF	100	×	0.1	×	×
3 Polynomial	100	×	0.1	10	1
4 Sigmoid	20	×	1	×	1

After obtaining the best combination of hyperparameter values for each kernel, testing is carried out to prove how suitable or how well the kernel tested in research is. Table 20 shows the results of the tests that have been carried out. It can be seen that the rbf kernel has the highest accuracy value with a value of 81.73%. Then, for the precision value, the sigmoid kernel has the highest value with 78.68%. The rbf kernel also has the highest recall value with 81.73%. Meanwhile, for the results

of the highest f1-score values are owned by two kernels, namely the rbf kernel and the sigmoid kernel with a value of 79.60%.

**Table 20. Test Results of Each Kernel Function**

Kernels	Parameter			
	Accuracy	Precision	Recall	F1-Score
1 Linear	80.77	77.33	80.77	78.93
2 RBF	81.73	78.27	81.73	79.60
3 Polynomial	78.85	75.28	78.85	76.22
4 Sigmoid	80.77	78.68	80.77	79.60

**e. Evaluation**

The evaluation process is carried out using a confusion matrix. The confusion matrix has a function to test how well the classification algorithm's performance model is built or used. The confusion matrix also provides comparative information between the actual classification results or the actual results and predictions. The confusion matrix structure used is based on Table 4.

**Table 21. Linear Kernel Confusion Matrix**

Actual	Prediction		
	Negative	Neutral	Positive
Negative	18	0	9
Neutral	0	0	4
Positive	7	0	66

In Table 21, the linear kernel tests 27 tweets with negative labels, 4 tweets with neutral labels, and 73 tweets with positive labels. It is found that the linear kernel detects classes in tweet data labeled negative as much as 18 for True Negative, and as many as 9 for False Positive. Then tweet data labeled neutral can only be detected for False Positive as much as 4 data. Then, 66 positive labeled tweets were detected for True Positive and 7 for False Negative.

**Table 22. Confusion Matrix Kernel RBF**

Actual	Prediction		
	Negative	Neutral	Positive
Negative	17	0	10
Neutral	0	0	4
Positive	5	0	68

In Table 22, kernel rbf, tweet data labeled negative was detected as many as 17 for True Negative, and as many as 10 for False Positive. Neutral labeled data detected as many as 4 for False Positive. Positively labeled tweet data was detected for 68 True Positives and 5 False Negatives.

In Table 23, kernel polynomial, negative labeled tweet data were detected as many as 14 for True Negative, and as many as 13 for False Positive. Neutral labeled data detected as many as 4 for False Positive. Positively labeled

tweet data was detected for True Positive as many as 68 and False Negative as many as 5.

**Table 23. Confusion Matrix Kernel Polynomial**

Actual	Prediction		
	Negative	Neutral	Positive
Negative	14	0	13
Neutral	0	0	4
Positive	5	0	68

**Table 24. Confusion Matrix Sigmoid Kernel**

Actual	Prediction		
	Negative	Neutral	Positive
Negative	17	2	8
Neutral	1	0	3
Positive	6	0	67

In Table 24, sigmoid kernel, 17 negative labeled tweet data were detected for True Negative, 2 tweet data for False Neutral, and 8 for False Positive. Neutral labeled data detected 3 for False Positive and 1 for False Negative. Positively labeled tweet data was detected for 67 True Positives and 6 False Negatives.

From the evaluation results using the confusion matrix, it can be seen that SVM and all SVM kernel functions can predict well.

After getting the rbf kernel function as the kernel with the best accuracy results, then displaying the sentiment classification with SVM on the test data from the dataset on Government Regulation No. 25 of 2020. The sentiment classification is carried out using SVM with the rbf kernel as the best kernel. The classification results are shown in Table 4.25.

**Table 25. Example of Sentiment Classification Results**

Final Tweet	SVM Results	Lexicon Results
Dengar tapera tabung rumah rakyat serta tapera klinikhukum	Positive	Positive
pns hak rumah tapera pegawai perintah penjurur indonesia serta program tabung rumah rakyat penuh syarat manfaat milik huni lokadata id	Positive	Positive
wasekjen demokrat perintah beban rakyat rumah wasekjen beban iur rakyat wajib negara penuh uang masyarakat utk dana tapera gaji sunat negara iur tapera gaji pegawai potong bayar pph bpjs sehat bpjs ketenagakerjaan yg bagi jht jamin pensiun jp	Positive	Negative
	Positive	Neutral

From the classification results, it shows that there are still differences in the results of the SVM and the results of the lexicon. Because, there is tweet data that should have a

negative value from the lexicon label, but the SVM results show it has a positive value.

**Table 26. Difference between Predictive and Actual Results**

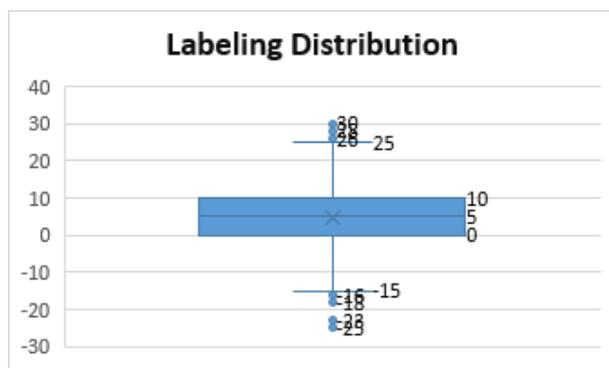
Label	Actual Results	Predictive Results
Negative	73	82
Neutral	27	22
Positive	4	0

#### 4. Discussion

##### a. Discussion of Research Results

The implementation of 5 preprocessing stages, namely the cleansing, case folding, tokenizing, stopwords, and stemming stages was successful for the need to change data that is still unstructured, still rough, and still has a lot of noise into ready-to-process data.

Then, the application of the lexicon-based method for the labeling needs of tweet data shows good results. Lexicon-based managed to label the tweet dataset with a total of 519 tweets. Lexicon-based labels tweets based on the accumulated weight of sentiment or opinion words in each tweet. The distribution of labeling values is shown in Figure 10. The largest labeling value is 30 and the smallest labeling value is -25. The results of lexicon-based labeling are used as a method to transfer learning to SVM through labeling tweet data.



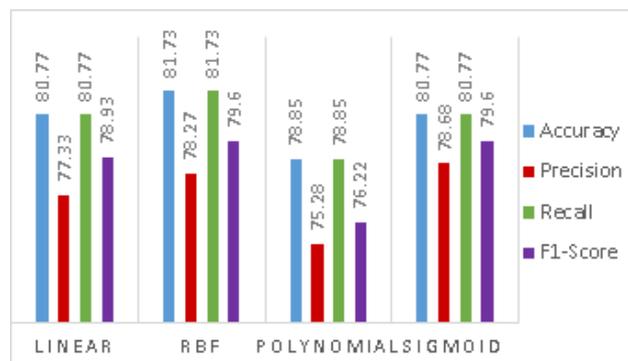
**Figure 10. Distribution of Data Labeling Results**

The dataset that already has a label is then weighted using TF-IDF. In the TF-IDF weighting process, the data is divided into train data and test data. The result of the TF-IDF weighting of the data train is the vector value and this vector value will be entered into the vector space to be processed using SVM. The result of vector space processing from the data train is a learning model. This learning model will be tested how well by test data. TF-IDF results from train data and test data are described in Table 16 and Table 17.

Processing using SVM is carried out based on four kernel functions, namely linear kernel, rbf kernel, polynomial kernel, and sigmoid kernel. The parameters used in each kernel are obtained through the hyperparameter tuning process using the grid search

method. This method serves to get the best combination of parameters for testing in each kernel function. The best combination of parameters that have been obtained for each kernel function is in Table 19. The test results for each SVM kernel function can be seen in the graph below.

From the graph of the kernel test results, it can be seen that the rbf kernel has the best test performance when viewed from the accuracy and recall values. When viewed based on the precision value, the sigmoid kernel has the best test results. Thus, the rbf kernel is the kernel with the best test performance, followed by the sigmoid kernel, then the linear kernel, and the polynomial kernel is the kernel with the lowest performance compared to other kernels in this test.



**Figure 11. SVM Kernel Test Result Chart**

In the evaluation, it can be seen how well the classification algorithm performance model is built based on the comparison of actual and predicted results with the confusion matrix.

Based on the results of the confusion matrix in each kernel in Tables 21 to 24, it can be seen that each kernel has a good performance for predicting tweet data with negative and positive labels. If described based on the example in Table 22, the rbf kernel succeeded in predicting 17 tweet data labeled negative correctly or True Negative, while the rbf kernel failed to predict 10 data labeled positive which should be categorized as negative, or can be called False Negative. Then, the rbf kernel, successfully predicting 68 tweet data labeled positive correctly or True Positive, also failed to predict 5 tweet data labeled negative which should be categorized on a positive label or can be called False Negative.

Although, the confusion matrix results of all kernel function tests have good performance in predicting data with negative and positive labels, however, all kernel test results are shown to fail to correctly predict tweet data with neutral labels. It can be seen in the results of the confusion matrix in Tables 21 to 24, all kernels fail to predict 4 positive-labeled tweet data that should be categorized on a neutral label or can be called False Positive. In other words, all tests of the four kernel functions failed to correctly predict the neutral-labeled tweet data.

The thing that causes a failure in testing the kernel function to predict tweet data with neutral labels, is due to

an unbalanced dataset. Unbalanced dataset is a condition where there is a significant difference in the distribution of class or data labels which results in non-ideal conditions in the classification. The results of the class distribution or data labels are shown in Figure 12. Unbalanced datasets cause the kernel test results on the confusion matrix to fail or fail. Because, unbalanced dataset causes the algorithm model to give prediction results into the dominant data class or label, or in this case the data is positively labeled. This is evidenced in the results of the confusion matrix in each kernel function, where all neutral tweet data is predicted to be positive tweet data.

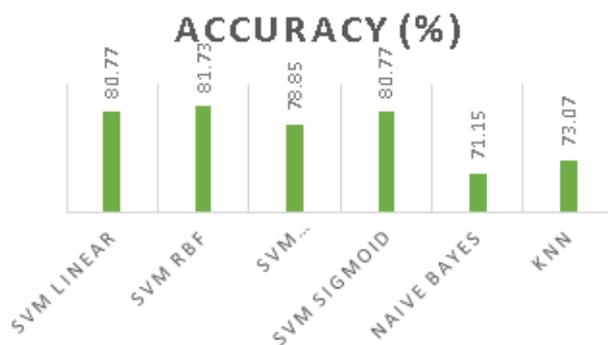
#### 4.2 Comparison of Accuracy Results

As a result of the proof based on the background of using the SVM algorithm that has been described previously, a test was carried out to compare the accuracy results based on the Naïve Bayes, KNN, and SVM algorithms. SVM results are taken from all kernel tests, namely linear, rbf, polynomial, and sigmoid kernels. For input hyperparameter values in the Naïve Bayes and KNN algorithms are described in Table 25.

**Table 27. Input Hyperparameters Nave Bayes and KNN Values**

Algorithm	Parameter	Value
Multinomial Naïve Bayes	Alpha	1, 0.7, 0.4, 0.2, 0.1, 0.09, 0.08, 0.07, 0.06, 0.03, 0.01
KNN	n_neighbours	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30

After determining the input values for the hyperparameters for the Naïve Bayes and KNN algorithms, testing is carried out to obtain the accuracy values. Then the accuracy value is compared to determine and prove that the accuracy of SVM is the best compared to Naïve Bayes and KNN. Comparison of accuracy results is shown in the graph below.



**Figure 12. Results of Comparison of Accuracy of SVM, Naïve Bayes, and KNN**

From the accuracy results, it can be seen that SVM is proven to have the best accuracy results. In fact, all SVM kernels have accuracy values above Naïve Bayes and KNN.

## 5. Conclusion

The analysis of the research results suggests that the application of the lexicon-based method for the data labeling process is successful. Lexicon-based managed to label 519 tweet data. The tweet data labels consist of 127 negative-labeled, 22 neutral, and 370 positive-labeled tweet data. The combination of lexicon-based and support vector machine algorithms also runs well. This combination goes sequentially, using lexicon-based to determine the sentiment value and the lexicon result data as labeling data for the support vector machine. This combination makes lexicon-based to transfer learning to SVM with the hope that it contributes to the sentiment labeling process to get good accuracy.

SVM was successfully implemented and supported by several methods such as preprocessing, data labeling, weighting with TF-IDF, and hyperparameter tuning with grid search. The highest accuracy results from the application of SVM with RBF kernel with an accuracy value of 81.73%. The sigmoid kernel has the highest precision at a level of 78.68%. SVM with RBF kernel attains the highest recall at 81.73%. Meanwhile, the RBF kernel and the sigmoid kernel achieve the highest F1 score at 79.6%.

Table 25 and Table 26 show discrepancies in labels by SVM and lexicon-based. SVM indicates a positive sentiment value for the negative lexicon label. However, the accuracy still shows a pretty good number at 81.73%.

Each kernel test has a pretty good result. The evaluation stage using the confusion matrix shows that each kernel function test can predict well the tweet data with negative and positive labels. However, all kernel tests show predictive failure for tweet data labeled neutral. The neutral tweet data is predicted positive. The error may happen due to the condition of unbalanced datasets. There are differences in the class distribution, or the data labels are significant. This condition makes the algorithm predict data into the dominant class.

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# Information System on Mapping and Geolocation of COVID-19 in the City of Sukabumi

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**Abstract** - Coronavirus Disease (COVID-19) has made Indonesia's health condition critical. Therefore, the President of the Republic of Indonesia disclosed Presidential Decree No. 7 in 2020 regarding the Task Force for the Acceleration of Coronavirus Disease 2019 (COVID-19) Handling. The decree relates to Act No. 14 in 2008 regarding Public Information Disclosure, Presidential Regulation No. 95 in 2018 concerning Electronic-Based Government Systems, and Presidential Instruction No. 3 in 2003 concerning National Policies and Strategies for E-Government Development. The decree demands information system development, similar to <https://covid19.go.id>, which describes COVID-19 nationwide. The site explains what COVID-19 and data of the COVID-19 outbreak with geolocation and digital map, which may attract public attention. The presidential instruction forces local governments to build an information system, which is in line with the site by the central government. This paper describes the development of the system using a spiral model. It involves a variety of free and open-source software such as CodeIgniter, Mapbox, Morris Chart, MySQL, and WordPress. The site has been operational, and it attracts 150 visitors a day with 200 visits per day. As of January 6, 2021, the website has recorded 89,852 views.

**Keywords:** covid, graphics, mapping, geolocation, spiral

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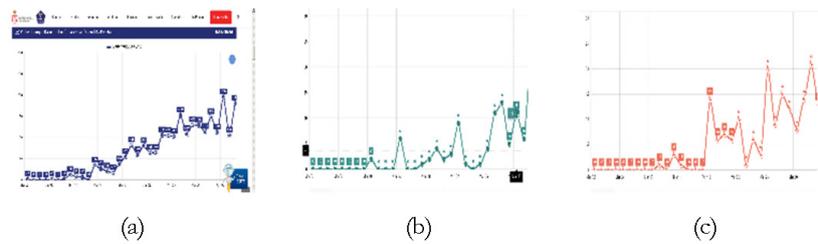
## 1. Introduction

COVID-19 in Indonesia was initially recorded on March 2, 2020, two residents were confirmed positive for COVID-19 who were later declared cured on March 10, 2020, until at the end of March 2020, there were 114 people confirmed, 6 people recovered, and 14 people died [1] as shown in Figure 1.

The data presented in Figure 1 is an accumulation of Level 2 areas, including Sukabumi City, which was sent via the COVID-19-19. Application Programming Interface (API). API is a tool that makes website data processed by a computer so that it can view and edit data without knowing the program code inside [2]. The use of APIs on the web has been widely used, as stated by Putra, Sasmita, and Wiranatha [3], who developed an e-commerce marketplace for pet shop, and previously the API was also used to access token of population data [4].

The President of the Republic of Indonesia Joko Widodo through the Decree of the President of the

Republic of Indonesia Number 9 of 2020 concerning Amendments to Presidential Decree Number 7 of 2020 concerning the Task Force for the Acceleration of Handling Coronavirus Disease 2019 (covid-19) [5] which is supported by Law Number 14 of 2008 concerning Transparency Public Information [6], Presidential Regulation of the Republic of Indonesia Number 95 of 2018 concerning Electronic-Based Government Systems [7], and Presidential Instruction Number 3 of 2003 concerning National Policies and Strategies for E-Government Development [8], emphasize that every regional head is obliged to develop information system related to Covid19, including Sukabumi City. From this instruction, the Mayor of Sukabumi, as the representative of the central government, ordered to build information disclosure regarding COVID-19 so that the surrounding community is more sensitive and alert about the dangers of the spread of COVID-19.



Source: [www.covid19.go.id](http://www.covid19.go.id)

Figure 1. Graph of COVID-19 in Indonesia in March. (a) positive confirmed data. (b) data recovered. (c) death data

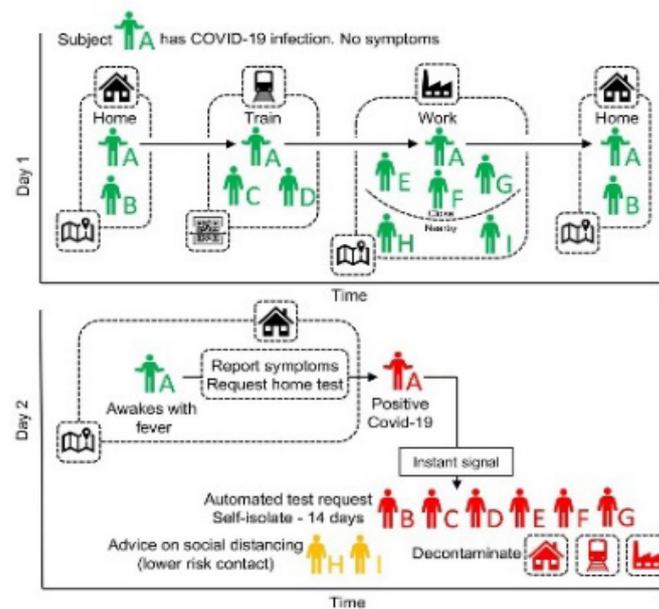


Figure 2. Covid 19 tracking techniques (Source: Ferretti et al.)

The time given is concise, and the need for engineering the information system includes mapping and geolocation of affected areas. Therefore, it needs a software engineering development strategy. This raises the formulation of the problem regarding how to make it easier for the public to know the development of Covid-19 around them, such as how to report in real-time to the Central Task Force and how to insert a digital map on the information systems. The information system engineering required by the government is also expected to track these COVID-19 victims. The tracking of Covid-19 victims needs to be carried out to find out how many people are exposed to this disease.

With the help of digital maps, it is now possible for the government to track the whereabouts of the victims of COVID-19 and the surrounding environment that must be protected and at which locations the victims were contaminated. Currently, there are digital map service providers, one of which is Mapbox which can be applied to various types of web-based information systems that also use APIs in their interactions with other sources that have existed since 2010 [9]. Therefore, in this way, it is easier for the government to trace the victims of COVID-19. The description of this covid19 tracking is demonstrated in Figure 2 according to Ferretti et al. [10].

To develop application/information software where the user requirement list (USR) in the form of a covid19 mapping requires a model that is by the user's condition, namely the Mayor of Sukabumi, in which the requested information system must be published immediately, dynamic in data changes, flexible input data, and easy to maintain when further development is required, and errors occur. The relation for this information system design team is that the system display can be described so that the requested system becomes workable, acceptable, and rational. In addition, the development of the COVID-19 map application is very sensitive and can have broad, multidimensional, and high-risk impacts. Hence, it is necessary to choose a system development approach that is suitable for these conditions, namely the adaptive System Development Life Cycle (SDLC) approach, one of which is the spiral model [11]. The main reason in using this spiral method is that the spiral model can work on the design and prototype side in one stage; it can also minimize the risk of technical work that must be avoided [12].

As an information system that has become public consumption, especially as a representation of the state, it requires software testing to ensure the system runs as it should. Software assessment using ISO-9126 is based on the Web Quality Evaluation Method (WebQem),

including functionality, efficiency, reliability, and usability [13]. To test more objectively, it requires special software to try, such as WAPT [14] to test reliability and Google Page Speed to test efficiency [15].

2. Methods

A systems development method guides every aspect of the systems development life cycle, which method uses specific models, techniques, and tools.

a. Model

Developing an information system requires a model that is by the conditions of the user, namely the Mayor of Sukabumi, in which the requested information system must be published immediately, dynamic in data changes, flexible in data input, can minimize the risk of work, and easy to maintain if further development is required and an error occurs. One model that fits these conditions is the spiral model. The advantage of the spiral model is that the stages of this model are simple, easy to understand for non-specialists, and most importantly, iterative in nature, where web application developers can return to previous phases when errors are found and make corrections to these errors—a spiral model whose general description can be seen in Figure 3.

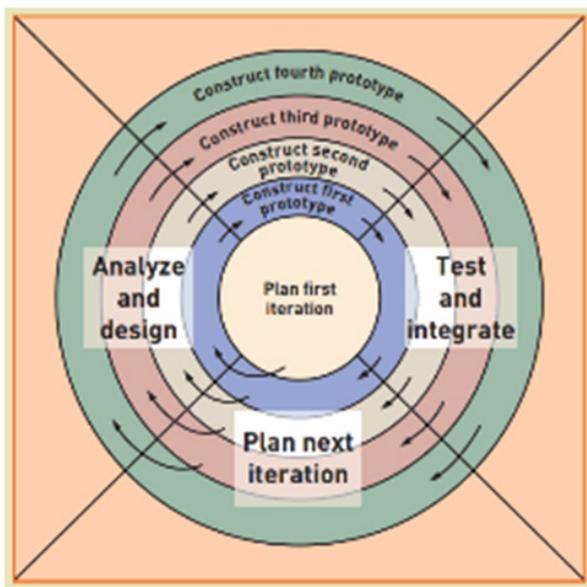


Figure 3. Spiral model

In the spiral model, the design and implementation of the program code that produces the prototype are in the same stage. The design and prototyping stages in work are the driving force behind the completion of the information system that is being worked on. Generally, programmers work on a subsystem one by one, starting from the design as the main display and then focusing on programming until the desired information system is completed.

b. Device

In system development requires devices such as,

1. Hardware: A set of computers with a 1Ghz Process Processor
2. Software: StarUML CodeIgniter Mysql Mapbox WordPress Morris Chart

c. Technique

In collecting information about detailed system requirements, several techniques need to be implemented, including user or other stakeholder interviews, reviewing input, output, and documentation, and also library studies.

d. System Analysis and Design

In completing the USR, it is necessary to interview users and see references from www.covid19.id, reviewing input, output, and literature study documentation is an indication of what the final form of the expected design. Based on interviews with the Health Office as the data owner, the example of data input for COVID-19 in Sukabumi City is displayed in Figure 4.

DATA KASUS YANG DILAKUKAN PEMANTAUAN DI KOTA SUKABUMI											
NO	KEURAJIAN	KASUS					KONFIRMASI				
		TOTAL	SURSK	ISOLASI	TOTAL	SELESAI	MENINGGAL	TOTAL	ISOLASI	SEMBUH	MENINGGAL
1	BABOJ	232	242	39	2	0	1	363	34	311	8
2	JAYARAKSA	1015	98	5	2	0	2	191	19	166	6
3	JAYAMEKAR	43	42	1	1	0	1	77	6	68	3
4	SUDAYATA HILIR	70	60	5	0	0	0	113	11	56	6
5	BABAKAN	135	119	16	1	0	1	272	27	240	5
6	CIBIRUJUHILIR	215	199	16	1	0	1	404	25	372	7
7	LUMENUNGGAL	125	115	10	1	0	1	186	18	162	6
8	SINDANGPALAY	89	86	3	0	0	0	167	9	153	5
9	CISARUA	308	279	29	0	0	0	440	49	389	8
0	SUBANG JAYA	202	191	11	1	0	1	382	35	342	5
11	KERUJATI	85	81	4	1	0	1	170	11	155	3
12	CIKOLE	93	89	4	0	0	0	244	13	225	6
13	SILABATU	190	183	7	0	0	0	367	31	329	7
14	GUNUNG PARANG	83	71	12	0	0	0	160	16	113	11
15	CIKONDONG	159	143	16	2	0	2	240	26	214	6
16	TIPAR	176	172	4	5	1	4	259	10	237	12
17	CIAMANG	146	141	5	1	1	0	204	15	183	6
18	GEDONG PANJANG	124	121	3	0	0	0	204	15	182	7
19	NANGILENG	294	282	12	1	0	1	465	24	430	21
20	GUNUNG PUTUH	191	179	12	1	1	0	332	28	296	8
21	SIWILAH	179	171	8	0	0	0	263	26	271	16
22	KARANG TENGAH	238	232	6	1	0	1	439	41	396	12
23	KARAMAT	132	130	2	1	0	1	265	20	235	10
24	CIKUNDU	52	50	2	1	0	1	90	10	76	4
25	CIPANENJAH	86	84	2	0	0	0	168	15	146	7
26	SINDANGSARI	35	35	0	0	0	0	67	6	59	2
27	LEMBURSITU	191	186	5	4	0	4	222	19	186	17
28	SUMBEKAR	64	53	1	0	0	0	82	48	73	5
29	BENTENG	192	184	8	1	0	1	308	29	265	14
30	DAYELUHUR	254	247	7	0	0	0	311	24	277	10
31	INTOMPONGS	119	127	2	1	0	1	244	20	211	13
32	MANIKKUNING	72	69	3	1	0	0	110	12	91	7
33	SUKAKARYA	248	232	16	3	0	3	332	28	293	11
UMUHAH		4915	4668	247	32	3	29	8155	681	7205	269

Figure 4. Sukabumi City Covid 19 input data

The location of the coordinates is marked using the village coordinates in Sukabumi City. The coordinate data for the village in Sukabumi City can be observed in Figure 5.

In addition to obtaining data held by the Sukabumi City Health Office as a URL, there is also data integration with the Sukabumi City Social Service in terms of disseminating information on social assistance data from the city to national levels. However, other reference results are taken from www.covid19.id which contains information and education, then adjusted to the needs of the City of Sukabumi, including important things for covid19, education, questions and answers, national task force, social media for handling COVID-19.

Based on the data mining process, the system design is based on USR, which can be clearly observed seen in Table 1. It is necessary to make guidelines such as use case

diagrams and class diagrams to keep on track. Use case diagrams to guide programmers so that the system built can perform and behave according to the results of the interview. The use case diagram using StartUML based on the USR, is illustrated in Figure 6.

id	kelurahan	kecamatan	lat	longi
1	Cikole	Cikole	-6.91815	106.931523
2	Selabatu	Cikole	-6.91152	106.929606
3	Gunung Parang	Cikole	-6.91966	106.925289
4	Subang Jaya	Cikole	-6.9157	106.950701
5	Cisarua	Cikole	-6.92077	106.940179
6	Kebon Jati	Cikole	-6.92007	106.936014
7	Gunung Puyuh	Gunung Puyuh	-6.91451	106.91675
8	Sriwedari	Gunung Puyuh	-6.91099	106.927114
9	Karamat	Gunung Puyuh	-6.90257	106.921469
10	Karang Tengah	Gunung Puyuh	-6.9151	106.906758
11	Benteng	Warudoyong	-6.91931	106.913316
12	Dayeuh Luhur	Warudoyong	-6.94084	106.913921
13	Sukakarya	Warudoyong	-6.92876	106.902541
14	Nyomplong	Warudoyong	-6.92983	106.920189
15	WaruDoyong	Warudoyong	-6.93401	106.920917
16	Tipar	Citamiang	-6.93127	106.927754
17	Cikondang	Citamiang	-6.9415	106.925449
18	Citamiang	Citamiang	-6.92997	106.930161
19	Gedong Panjang	Citamiang	-6.94197	106.931068
20	Nanggaleng	Citamiang	-6.93423	106.934831
21	Babakan	Cibeureum	-6.92973	106.957602
22	Cibeureum Hilir	Cibeureum	-6.93109	106.94562
23	Sindang Palay	Cibeureum	-6.95481	106.949443
24	Limus Nunggal	Cibeureum	-6.94755	106.942715
25	Baros	Baros	-6.96262	106.940262
26	Jaya Raksa	Baros	-6.9507	106.932739
27	Jaya Mekar	Baros	-6.96326	106.924807
28	Sudajaya Hilir	Baros	-6.9524	106.921794
29	Cikundul	Lembur Situ	-6.97586	106.910516
30	Sindang Sari	Lembur Situ	-6.95258	106.917226
31	Cipanengah	Lembur Situ	-6.96394	106.907641
32	Lembur Situ	Lembur Situ	-6.95948	106.891531
33	Situmekar	Lembur Situ	-6.94919	106.914165

Figure 5. Coordinate data for Sukabumi City village

Table 1. User Requirement List (URL)

No	List of needs
1	There is a site covid19.sukabumikota.go.id
2	There is a covid19 mapping in Sukabumi City
3	There is a graph of covid19 in Sukabumi City
4	There is the dissemination of social assistance from the Sukabumi City Social Service
5	Go to www.covid19.id and pikobar.jabarprov.go.id
6	Covid-19 education
7	COVID-19 FAQ
8	API link to the national task force
9	Social media for handling covid 19.

The class diagram is a structure diagram created to describe the relationship between model classes in the system. The class diagram design is illustrated in Figure 7.

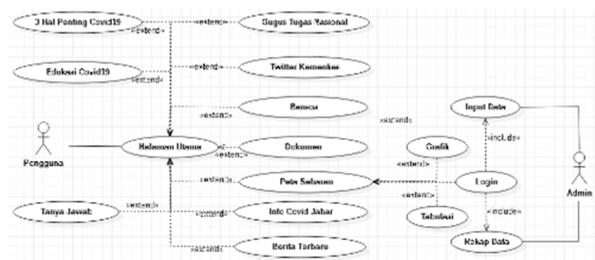


Figure 6. Use Case Diagram

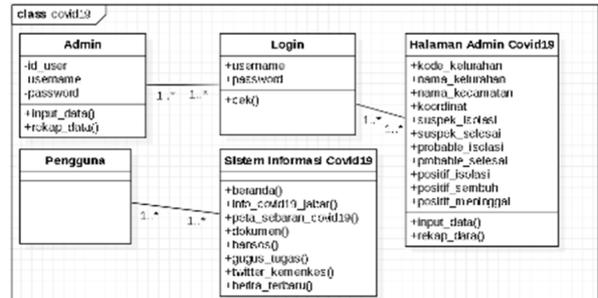


Figure 7. Class Diagram

The spiral model used in the development of this system produces a prototype that can produce the precise and correct output as required to minimize errors. The database used in this study uses MySQL database programming with database applications using Adminer, which can be accessed through the <https://www.adminer.org> site.

**e. Implementation Time and Place**

The time of research was carried out from March to May 2020 at the Office of Communication and Information of Sukabumi City, West Java.

**f. Testing**

Due to the fast demand for an immediate launch, this test uses the BlackBox testing method which aims to find any discrepancies based on the user's point of view. The results of this test are in the form of a prototype application that is being developed.

**g. Assessment**

The assessment uses the ISO 9126 standard, which identifies six characteristics of quality software such as:

- 1) Functionality. Assessment of functional aspects using a Feature Completeness assessor. The formula for calculating Feature Completeness is shown in Eq. 1,

$$X = \frac{i}{P} \tag{1}$$

Information:  
P = Number of designed features

$i$  = Number of features successfully implemented

- 2) Reliability  
The reliability assessment uses WAPT 10 with a ramp-up type where the number of users increases until it reaches a predetermined maximum value. This results in information that the software/server can run well or not.
- 3) Usability  
Assessment of the usability factor of the System Usability Scale (SUS) in which respondents from the general public were asked to provide an evaluation of "Very Informative" (SI) with a value of 5, "Informative" (I) with a value of 4, "Less Informative" (KI) with a value of 3, "Not Informative" (TI) with a score of 2, and "Don't Know" (TT) with a score of 1 on a Likert scale. The questions distributed are shown in Table 2.

**Table 2. Question table for usability testing**

Code	List of needs
R1	How informative is the information provided by the Sukabumi City Government regarding COVID-19?
R2	How informative is the information on <a href="http://www.covid19.sukabumikota.go.id">www.covid19.sukabumikota.go.id</a> ?
R3	How informative is the COVID-19 data tabulation on <a href="http://www.covid19.sukabumikota.go.id">www.covid19.sukabumikota.go.id</a> ?
R4	How informative is the covid19 digital map on <a href="http://www.covid19.sukabumikota.go.id">www.covid19.sukabumikota.go.id</a> ?
R5	How informative is the covid19 graphic on <a href="http://www.covid19.sukabumikota.go.id">www.covid19.sukabumikota.go.id</a> ?
R6	How informative is the visit chart on <a href="http://www.covid19.sukabumikota.go.id">www.covid19.sukabumikota.go.id</a> ?
R7	How informative is the information for residents who have received COVID-19 social assistance found on <a href="http://www.covid19.sukabumikota.go.id">www.covid19.sukabumikota.go.id</a> ?
R8	How informative is the COVID-19 educational information on <a href="http://www.covid19.sukabumikota.go.id">www.covid19.sukabumikota.go.id</a> ?
R9	How informative is the social media information on <a href="http://www.covid19.sukabumikota.go.id">www.covid19.sukabumikota.go.id</a> ?

The table 2 questionnaire is distributed using a google form with a site address such as <https://forms.gle/q2zwK9e2fpk5etKQA>. The questionnaire data was calculated using the Cronbach Alpha formula [17], formulated as Eq. 2.

$$\alpha = \frac{k}{k-1} \left( 1 - \frac{\sum S_i^2}{S^2} \right) \quad (2)$$

The value of  $k$  is the number of items, is the variance of the  $i$ -th item, and the variance of the total score formed by adding up all the items. The calculation of Eq. 2 has been represented through the website [http://www.wessa.net/rwasp\\_cronbach.wasp](http://www.wessa.net/rwasp_cronbach.wasp) [18] with the interpretation of the reliability value of Cronbach's Alpha shown in Table 3 [14].

**Table 2. Cronbach Alpha reliability assessment table**

No.	Score	Grade
R1	$R > 0.9$	Excellent
R2	$0.9 > R > 0.8$	Good
R3	$0.8 > R > 0.7$	Acceptable
R4	$0.7 > R > 0.6$	Questionable
R5	$0.6 > R > 0.5$	Poor
R6	$R < 0.5$	Unacceptable

- 4) Efficiency  
Efficiency factor assessment is carried out using Page Speed from Google. The methodology that Google uses is to measure website responsiveness which websites should avoid landing page redirects, measure compression, measure browser cache, measure CSS minify, measure HTML minify, measure JavaScript minify, measure image optimization, measure visible content priority, and measure server response time [16].

### 3. Result

Information system design guidelines that are compiled based on URLs, then implemented using use cases, and class diagrams are implemented in programming form. Our programming combines various softwares such as framework programming using CodeIgniter 3 and WordPress, graphs using Morris Chart, digital maps using Mapbox, and databases using MySQL.

The database was built using MySQL, in which the tables were made according to the data provided by the Health Service as presented in Figure 4 and Figure 5. Based on the data in Figure 4, it was normalized into two tables. The first table is used to store data on the current day. The second table is used to store historical data that has existed since the first case appeared in Sukabumi City. In the second table, this is the basis for the graph of the increase and decrease in the number of COVID-19 in Sukabumi City.

The main page on the [covid19.sukabumikota.go.id](http://covid19.sukabumikota.go.id) site uses WordPress 5.4.4. This is because of the convenience offered by WordPress, one of which is when there is damage by hackers which can immediately be repaired. One way to fix a WordPress site that was attacked by hackers is by restoring WordPress, which has previously been backed up, both content and database. Until January 6, 2021, since its launch, the system can display a total of 2045 confirmed positive patients, consisting of 597 (29.19%) people being treated (self-isolating), 1,386 (67.77%) people recovering, and 62 (3.03%) people dying. This site has been viewed 89,852 times with an average visit of 607.13 visits/day and an average visitor of 274.38 visitors/day, which is the visit graph on the main page of the [covid19.sukabumikota.go.id](http://covid19.sukabumikota.go.id) site, which can be seen in Figure 8.



## b. Chart

The graph used for covid19.sukabumikota.go.id uses a line-type Morris Chart, which corresponds to the time series of covid19 data in Sukabumi City. By using chart, people are aware of the dramatic increase in data which makes them even wavier. The chart of patient status in the March to July edition consists of ODP (Completed Monitoring, Under Monitoring), PDP (Completed Monitoring, Under Monitoring), Positive (Recovered, Under Care, Died). As for August, it has become Suspect (Isolation and Completed), Probable (Isolation and Completed), Positive Confirmation (Isolation, Healed, Died). The graphic display of the covid19.sukabumikota.go.id site can be observed in Figure 8.

The graphics developed in Sukabumi City, the program code is processed in such a way that it can be viewed based on the city, sub-district, and village levels. The data selection for each level uses SQL in such a way that when inserted into the Morris chart javascript function it produces a data structure as shown in Figure 12.

```
function getMorris(type, element) {
  Morris.Line( {
    element: element,
    data: [ { 'period': '2020-03-27', 'ODP_Selesai': 30,'ODP_
      Dalam_Pantauan': 57, 'PDP_Selesai': 2,'PDP_Dalam_Pengawasan':
      13,'Positif_Meninggal': 0,'Positif_Sembuh': 0,'Positif_Perawatan': 0
    },
    {
      'period': '2020-03-28', 'ODP_Selesai': 41,'ODP_Dalam_Pantauan':
      61,'PDP_Selesai': 3, 'PDP_Dalam_Pengawasan': 12, 'Positif_
      Meninggal': 0,'Positif_Sembuh': 0, 'Positif_Perawatan': 0
    }
  ]},
  xkey: 'period',
  ykeys: ['ODP_Selesai', 'ODP_Dalam_Pantauan', 'PDP_Selesai',
    'PDP_Dalam_Pengawasan', 'Positif_Meninggal', 'Positif_Sembuh',
    'Positif_Perawatan'],
  labels: ['ODP_Selesai', 'ODP_Dalam_Pantauan', 'PDP_Selesai',
    'PDP_Dalam_Pengawasan', 'Positif_Meninggal', 'Positif_Sembuh',
    'Positif_Perawatan'],
  lineColors: [
    'rgba( 0, 188, 212)', 'rgba(233, 30, 99)', 'rgba(100, 50,
    50)', 'rgba(150, 100, 100)', 'rgba(244, 0, 0)', 'rgba(8, 130,
    27)', 'rgba(153, 7, 20)'
  ], LineWidth: 2
  });}
```

Figure 12. Graph program code using Morris Chart

In the graph, the visits come from the visits and visitors tables. Both are WordPress counter plugins. The way this plugin works is to count one of the pages visited by a visitor. The results of these calculations are stored in the visit table. Whereas, in the visitor table, apart from counting one of the pages visited, it also checks the visitor's IP address whether it has existed before or not on the same date. If the IP address already exists, it is only considered one visitor.

## c. API

The use of the API on the covid19.sukabumikota.go.id site is essentially just sharing data with anyone, especially with the national task force. Schematic data transactions that occur between the local government site as a server and the National Task Force site as a service requester. The REST API is used for data transactions with the National Task Force. In CodeIgniter this API configuration is located in the rest.php file in the Config folder, and some parameters are set to `$config['rest_key_name']='X-API-KEY';$config['rest_key_column']='key';` on the URL covid19.sukabumikota.go.id/new/index.php/covid19/index\_get.

## d. Evaluation

Application assessment using the ISO 9126 Standard includes:

### 1) Functionality (X)

Assessment of functionality and calculation of Feature Completeness using formula (1) which the result becomes  $X = \frac{i}{P} = \frac{9}{9} = 1$ . The result of the value of 1 shows that what is being done is by the URL.

### 2) Reliability

In the reliability assessment using the WAPT 10 software with a ramp-up test type scheme, there are 5 active virtual users. The virtual users increase and access every 10 seconds, and the test time is 10 minutes. The result is displayed in Figure 13.

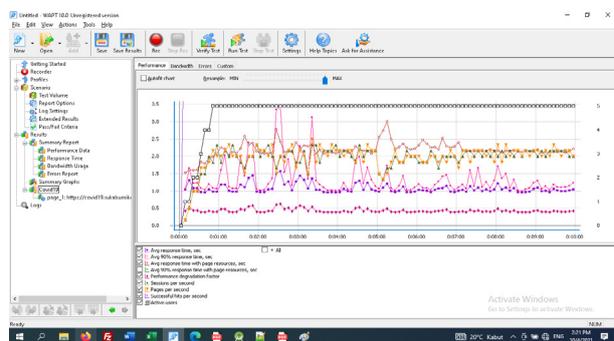


Figure 13. The results of reliability testing using WAPT 10

Based on Figure 13, resulting in five virtual users can be served < 1 second first. Average response time from 0.96 seconds to 1.58 seconds, the number of pages per second starting from 1.33 pages/second to 2.5 pages/second.

### 3) Usability

Based on the results of the questionnaire that was distributed via <https://forms.gle/q2zwK9e2fpk5etKQA> from October 1 to October 9, 2021, 62 respondents were involved, which can be seen in Figure 14.

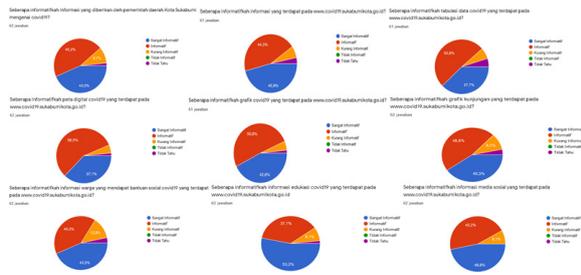


Figure 14. Questionnaire Results Via <https://forms.gle/q2zwK9e2fpk5etKQA>

Questionnaire data that has been obtained by calculating Cronbach's Alpha value using Eq. 2. through the website [http://www.wessa.net/rwasp\\_cronbach.wasp](http://www.wessa.net/rwasp_cronbach.wasp). The results is shown in Figure 15.

Items	Cronbach Alpha	Std. Alpha	G6(smc)	Average R
All itmes	0.9436	0.9446	0.9667	0.6544
Q1 excluded	0.933	0.9338	0.9577	0.638
Q2 excluded	0.9381	0.9386	0.9653	0.6564
Q3 excluded	0.9373	0.9383	0.9628	0.6553
Q4 excluded	0.9325	0.9325	0.9552	0.6334
Q5 excluded	0.9364	0.9371	0.9549	0.6507
Q6 excluded	0.9317	0.9338	0.9577	0.638
Q7 excluded	0.9332	0.9351	0.9574	0.6429
Q8 excluded	0.9444	0.9461	0.9602	0.687
Q9 excluded	0.9448	0.9462	0.9627	0.6875

Figure 15. Cronbach Alpha calculation results via software with a ramp-up test type scheme, there are 5 active [http://www.wessa.net/rwasp\\_cronbach.wasp](http://www.wessa.net/rwasp_cronbach.wasp)

4) Efficiency

Efficiency assessment using Page Speed from Google was conducted on October 8, 2021, at around 19:00 WIB. The result is First Contentful Paint reaches 0.7 seconds, Largest Contentful Paint reaches 3 seconds, Cumulative Layout Shift reaches 0.4 seconds, Time to Interactive reaches 5 seconds, Total Blocking Time reaches 180 milliseconds, and Speed Index reaches 7.4 seconds which is presented in Figure 16.

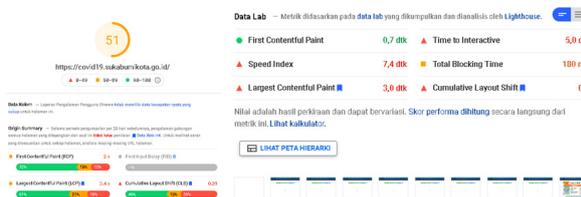


Figure 16. Google Pagespeed assessment results

5. Conclusion

The Covid19 information system, which aims to provide information to the people of the city of Sukabumi, has been completed and successfully developed. This can be seen from the large average number of visits and visitors every day, which reached 607.13 visits per day and 274.38 visitors per day for almost a year. With the spiral model,

the interests of stakeholders can be appropriately fulfilled, and the development time can be adjusted to the character of the stakeholders. The use of geolocation and mapping of COVID-19 patients can be implemented and used. Nonetheless, the patient's coordinate points are shifted to the coordinates of the sub-districts in Sukabumi City. Based on a chart dated January 6, 2021, as many as 2045 people were exposed to COVID-19, and the daily increase in confirmed positive patients generally increases, including data on recovery and death. These positive confirmed patients consisted of 597 (29.19%) people being treated (self-isolating), 1,386 (67.77%) people recovering, and 62 (3.03%) people dying. Even though the death rate is still relatively low, underestimating the problem is not wise and even considered wrong. Data transactions sent to the National Task Force were successfully carried out using the [covid19.sukabumikota.go.id/new/index.php/covid19/index\\_get](https://covid19.sukabumikota.go.id/new/index.php/covid19/index_get) website.

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# Detection of Highway Lane using Color Filtering and Line Determination

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**Abstract** - Traffic accidents are generally caused by human error as a driver. The main cause is that the vehicle shifts away from the driving lane without the driver realizing it. Usually because the driver is sleepy or drunk. Therefore, it is necessary to have a system that functions to assist the driver's navigation to stay on the correct driving path, such as a driver assistance system (DAS). In this system, the driving lane detector is the main part. This system serves to assist the driver's navigation to stay on the correct driving path. Vehicles are installed with cameras to record video towards the road ahead. Computers are also installed for image processing, identifying left and right road lines and forming ego-lane. This paper offers an image processing-based method for recognizing driving lane and presenting visualizations in real time. This method has been tested using a data set, that video driving on Indonesian highway on the Cipali and Palikanci sections using dashboard camera. The test results obtained an accuracy of 99.25%.

**Keywords:** lane detector, camera, image processing, Indonesian highway, real time, accuracy

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## 1. Introduction

The line on the road surface is helpful as a guide for the driver to direct his vehicle. This line has various forms, namely dash lines and solid lines. Its application on the road can be in the form of single lines and double lines. The colors used for the road markings are generally white and yellow, following the Regulation of the Minister of Transportation of the Republic of Indonesia No. 34 of 2014 concerning Road Marking. In this regulation, it is also explained that the dash line-markings function as lane dividers, traffic directors, this line have a minimum width of 10 cm. These dash lines have the same length, 3 meters for designations with a vehicle design speed of less than 60 Km/h with a distance between lines of 5 meters. As for the design speed of vehicles more than 60 Km/h, the line length is 5 meters, and the distance between lines is 8 meters. The solid line functions as a barrier, and divides the path and prohibit crossing this line. The thickness of the solid line as a roadside barrier is at least 10 cm and 15 cm for highway. Identifying and tracking road lines is key to developing algorithms for driver guidance systems or driverless vehicles.

The driver assistance system (DAS) is constantly evolving. The development of DAS was started from Lane Keeping Assistance (LKA), Lane Departure Warning System (LDWS), Lane Centering Assist (LCA), to

Advanced Driver Assistance System (ADAS). In recent years essential ADAS functions such as LKA, LDWS and LCA have become common in the middle-class cars [1]. The utilization of the assistance system is expected to reduce accidents events.

LKA is a system where the vehicle will maintain its position to remain in the driving lane. LDWS is a system where an alarm will sound to warn the driver that the vehicle moves away from the driving lane. LCA is a system that helps the vehicle to stay in the middle of the driving lane. Suppose the vehicle is somewhat shifted to the right. In that case, the system will automatically adjust the steering wheel slightly to the left so that the vehicle position remains in the middle of the driving lane. The three methods above will turn off if the driver turns on the turn signal sign turning left or right, usually used to change lanes.

While ADAS has a broader meaning because it includes control of the Anti-lock Braking System (ABS), cruise control, blind-spot monitoring, auto parking control, and communications for navigation. ADAS generally uses multiple sensors, including LIDAR, radar, camera, image processing and computer vision.

A good highway must have a clear road line. With the condition of excellent and clear road line markings and long roads, drivers can use this to activate the ADAS system on their vehicles. It will help the driver rest for along this road.

Research on lane detection has been carried out, among others: Weiwei Chen et al. conducted a review of lane detection in image processing and semantics and concluded that research on lane detection is still a challenge [2]. Li Yong Ma et al. introduced adaptive threshold segmentation of lane gradient images by combining the Canny edge detection technique and the ONSU algorithm [3]. Peerawat et al. used Randomize Hough Transform to detect lane driving and claimed that the computation time was shorter than the standard Hough Transform [4]. Jinsheng Xiao et al. used an extended Kalman filter to detect lanes and claimed that the recognition rate was better than the RANSAC method [5]. Trun-Thrien Tran et al. used the HSI color system to help detect lane driving and showed that the results were much better than RGB color space [6]. Kyoungtaek Choi et al. introduced ego path detection using a method based on the endpoint of the highway path by comparing it with positional data obtained from GPS [7]. Chin-Pang Huan et al. introduced an adaptive road mask to detect lanes by determining the vanishing point and recalculating the ROI [8]. A. F. Cela et al. proposed an algorithm to detect road lanes based on unsupervised and adaptive classifiers using HSV images [9]. J. G. Kuk et al. presented a computationally efficient and robust path detection algorithm based on the Hough transform [10]. Chao Li et al. succeeded in detecting multi-lane using a Kalman filter and a monocular camera [11]. VioLET, introduced by J. C. McCall and M. M. Trivedi, is a system that can detect and track driving lanes [12]. P. V. Date and V. Gaikwad combine image processing with fuzzy logic to determine the lane detection and departure warning system [13].

Implementing a driving lane detector using image processing is highly dependent on the road environment. Roads must have clear and uniform road lines. Based on the regulations in Indonesia, there are several types of road lines, namely dash lines, and solid lines. The lines have to be colored in either white or yellow. Problems that often occur are exposure to light on the road, shadows on the road, faded road lines due to weather, peeling road lines, and bad weather [14]. Some methods can improve the image quality, namely Retinex [15], [16]. Using Retinex, the problems can be minimised. However, there will be other problems, for example, the computational process that is increasingly complex and time-consuming.

The paper consists of four sections. The first section introduces research background and presents previous works related with this paper. The second section discuss the method used in this research. The method is constructed by a sequence of processing steps, namely data video acquisition, ROI determination, blur correction, HSL-grayscale color conversion, the edge and line detections, and ended by drawing lines to the video frames. The algorithm results are described in the third section. The fourth section concludes and summaries all facts found in the research. The author acknowledgment is given in the end of the paper.

## 1. Methods

Most lanes are designed to be relatively easy not only to encourage order but also to make it easier for human drivers to drive vehicles at a consistent speed. Therefore, the first approach is to detect straight lines using edge detection and feature extraction techniques. We will use OpenCV, an open-source library of computer vision algorithms.

The method can be explained as follows: applying ROI (Region of Interest), blur correction using Gaussian Blur function, changing the color system from RGB (Red Green Blue) to HSL (Hue Saturation Lightness), applying an HSL filter to a color that matches the color of the road line, changing to a grayscale image, applying the canny function, applying the houghLine function, forming left and right lines, forming an area driving lane, overlay with origin image. Repeat this process to the next image. The proposed method can be described as a flowchart and codeblock, as shown in Figure 1 and 2, respectively.

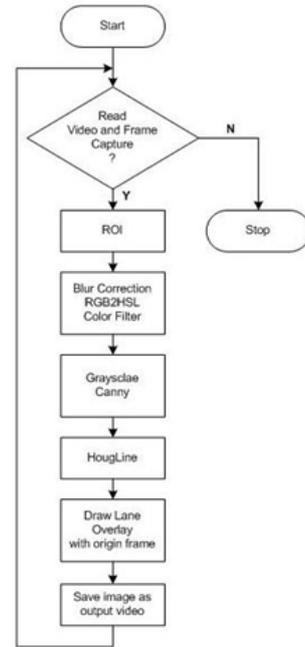


Figure 1. Flowchart of method

```

while openedCamera == True do
  IRGB ← capture(video)
  IRGB ← ROI(IRGB)
  IRGB ← GaussianBlur(IRGB, filterSize=5)
  IHSL ← colorConversionRGBtoHLS(IRGB)
  Iw ← intensityMask(IHSL, wThlow ≤ IHSL ≤ wThup) //white line threshold
  Iy ← intensityMask(IHSL, yThlow ≤ IHSL ≤ yThup) //yellow line threshold
  Imask ← Iw ∪ Iy
  Icanny ← edgeDetection(Imask, filterType=Canny)
  lines ← lineDetection(Icanny, filterType=Hough)
  Ilines ← drawLines(IRGB, lines)
end
  
```

Figure 2. Codeblock of method

### a. Read Video and Frame Capture

The first step, read the video and capture a single video frame (an image), cv2.VideoCapture(videoFile). The

captured image is 1280 ×720 pixels in size. There are 30 frames in 1 second video duration. An example of image capture results can be seen in Figure 3.



Figure 3. Display a frame from video capture

**b. The ROI Determination**

The next step is to determine the ROI, which is an interesting area to focus on. Within this area, several objects must be observed, while objects outside the ROI can be ignored. The shape of the ROI can be adjusted to the needs of the observations. It can be a square, triangle, circle, trapezoid or other polylines. Areas outside the ROI can be masked, for example, made black using the `zeros_like` and `bitwise_and` function. The image pixels in ROI will be preserved as its origin, while outside the ROI will be made black. Using ROI makes the computational load smaller and faster. This article uses a trapezoid ROI. The ROI and masking in the image can be seen in Figure 4.



Figure 4. Display a frame with ROI and mask

**c. Blur Correction, Convert to HSL and Color Filter**

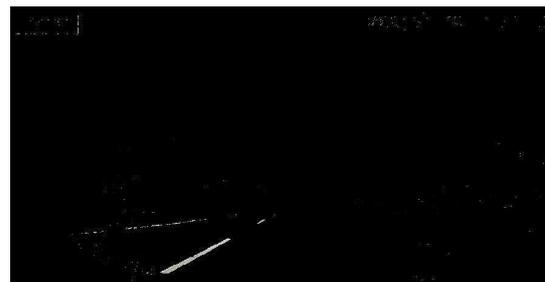
The next step is blur correction and changing the RGB color system to HSL. The RGB color system can be written as `rgb[red, green, blue]`, which combines the three basic colors. These three basic color parameters can be adjusted in intensity with integer numbers 0 to 255. Thus `rgb[255, 0, 0]` represents red, `rgb[0, 255, 0]` is green, and `rgb[0, 0, 255]` is blue. The RGB colour system makes it very difficult to represent a color due to differences in light exposure and color saturation.

The HSL color system can be described as a geometric cylinder. Hue values from 0-360 degrees, with a value of 0 being red. Increasing the value of the hue to 60, then it turns yellow. Hue equals 120 is green, 180 is cyan, 240 is blue, 300 is magenta, and back to 360 is red. Saturation and lightning values are between 0-100%, where pure color occurs at  $S=100%$  and  $L=50%$ . With a value of  $L =$

0, all colors will be black, and with a value of  $L=100%$ , all colors will be white. Writing format as `hsl[hue, saturation, lightness]`, for example `hsl[0, 100%, 50%]` displays pure red color. While pure blue is written as `hsl[270, 100%, 50%]`.

Where the lower limit value of yellow is `yel_low` and the upper limit value is `yel_up`. Likewise with white color, namely `white_low` and `white_up`. A program has been created to determine the range of white and yellow colors that are passed. The white lower and white upper values can be set by sliding the slide bar. Then repeat using program to determine the lower and upper limits of yellow. The algorithm extracts the white lane by applying the intensity intervals as follows. The interval values of H, S, and L, are defined at 60 to 255, 130 to 255, and 15 to 45, respectively. The algorithm can find the yellow lane by only accepting the H, S, L values within the range of 90 to 255. The values outside this range will be either minimised to 0 or maximised to 255. The result is as in Figure 5.

In this case, the HSL range values for white are determined as follows: lower threshold [60, 130, 15] and upper threshold (255, 255, 45). In yellow, lower threshold [90, 90, 90] and upper threshold (255, 255, 255]. Combining white and yellow filters produces the image shown in Figure 6.



(a)



(b)

Figure 5. Applying algorithm to extract (a) white and (b) yellow

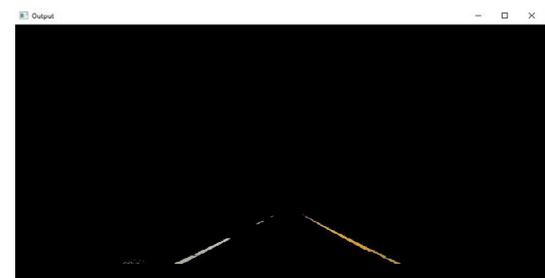


Figure 6. Frame view with ROI and white and yellow color filters

#### d. Grayscale and Canny Operation

The next step, grayscale and canny operations are performed. Canny edge detector is a method used to find edges in an image. Canny edge detection algorithm consists of several steps as follows: noise reduction, gradient calculation, non-maximum suppression, double threshold and edge tracking by hysteresis. In openCV library, there is a function to convert the image to grayscale and a Canny edge detector function. The result is shown in Figure 7.

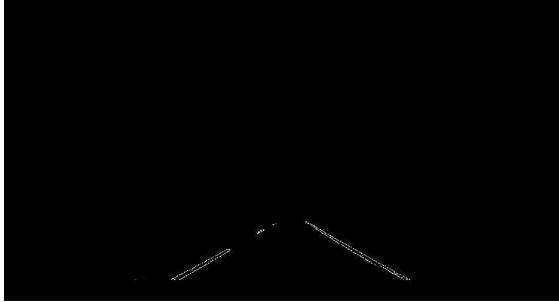


Figure 7. Grayscale and canny operation results

#### e. Hough Transform and Draw Lines

From the Canny image, a Hough Transform operation is performed to detect the lines in this image. Hough transform produces multiple lines. For example, a line from point  $A(x_a, y_a)$  to point  $B(x_b, y_b)$ , then the gradient or slope can be calculated by equation (1). Referring to the middle point of ROI, then from the slope value it can be seen that the line is on the left side if the slope is negative. The line is on the right if the slope is positive. y-intercept can be calculated by equation (2).

$$\text{slope} = \frac{(y_a - y_b)}{(x_a - x_b)} \quad (1)$$

$$\text{yintercept} = y_b - (\text{slope} * x_b) \quad (2)$$

The many lines generated by the hough transform can be calculated the average slope (avgslope). Calculations are made on the left and right sides of the line. Similarly, it is necessary to calculate the average y-intercept.

The positions of  $x_1$  and  $x_2$  can be seen from the illustration in Figure 7. From the average slope value and the values of the  $y_1$  and  $y_2$  coordinates determined, the importance of  $x_1$  and  $x_2$  can be calculated by the equation (3) and (4).

$$x_1 = (y_1 - \text{yintercept}) / \text{avgslope} \quad (3)$$

$$x_2 = (y_2 - \text{yintercept}) / \text{avgslope} \quad (4)$$

where  $y_1$  is the same as the top y in the ROI plane, and  $y_2$  is image height, as shown in Figure 8.

By knowing four points, namely  $(x_1, y_1)$  left,  $(x_2, y_2)$  left,  $(x_1, y_1)$  right and  $(x_2, y_2)$  right, it forms a closed polyline. The result is shown in Figure 9 and then overlaid with the original image. The result is as shown in Figure 10. And so on, it is processed again for the next video frame.

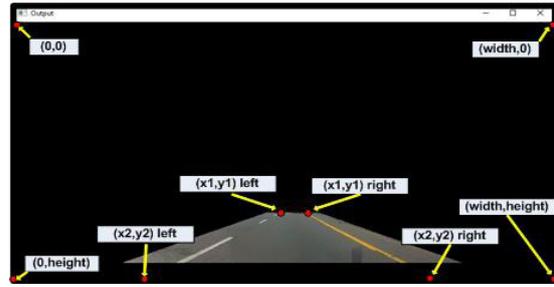


Figure 8. Position of X1, Y1 and X2, Y2 , left and right

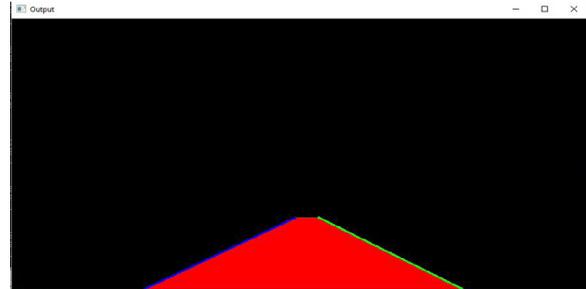


Figure 8. Closed Polyline as driving lane

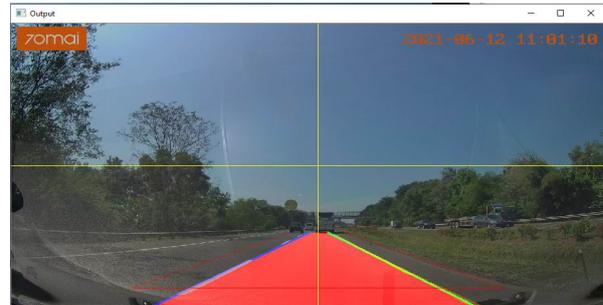


Figure 9. The final result is a driving lane on the video frame

We use video recordings of driving trips that show the left and right road lines to test our method. We use a dashboard camera installed in the cabin, in front of the center mirror, as in Figure 11.



Figure 10. In-vehicle camera installation

Camera settings for recording 3 minutes video clip in mp4 format at a resolution of 1280x720 pixels. The camera frame rate is set at 30 fps. Dashcam video recording on the Cipali highway from KM 166 produced 3 videos, Cipali\_1, Cipali\_2 and Cipali\_3. The road texture in this section is a mixture of concrete and asphalt-coated

concrete roads. The Palikanci highway section from km 207, produced 3 videos, Palikanci\_1, Palikanci\_2 and Palikanci\_3. The Palikanci highway section has a hot mix asphalt texture. Video capture during the day from 10.31 am to 11.10 am. Execution of program code with 6 video inputs above produces 6 output videos in avi format.

### 3. Result and Discussion

To calculate the accuracy of the lane detector, we use the Intersection over Union (IoU) method, as depicted in Figure 12. By comparing the ground truth image and the predicted image. Ground truth can be explained as a reality desired to be predicted by a model (system), through direct measurement and observation of objects. In this case, the ground truth can be created manually, that is, an area between the left and right road lines on the ego-lane, with the upper point is the same as the ROI upper point, and the lower point is the same the image lower point. At the same time, the detection result is the overlay generated by the model as lane detected. Furthermore, the ground truth and overlay images are changed to binary images (black and white), as shown in Figure 13. By counting the number of pixels in intersection and union, the accuracy can be calculated. The IoU value is computed by applying Equation 5.

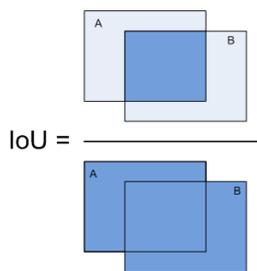


Figure 11. The IoU concept to calculate accuracy.

$$IoU = \frac{A \cap B}{A \cup B} \tag{5}$$

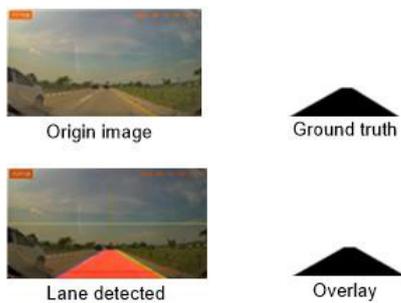


Figure 12. Binary image of ground truth and lane detected

From six output videos is sampled ten images respectively. In some cases, the image cannot be used as a sample, for example, when the vehicle changes lanes. Using out\_cipali\_1.avi, we sampled ten images, as shown in Table 1.

Table 1. Image sampling from video out\_cipali\_1.avi

No	File name	image
1	cip1_1.jpg	
2	cip1_2.jpg	
3	cip1_3.jpg	
4	cip1_4.jpg	
5	cip1_5.jpg	
6	cip1_6.jpg	
7	cip1_7.jpg	
8	cip1_8.jpg	
9	cip1_9.jpg	
10	cip1_10.jpg	

The sampled image is calculated for ground truth and its overlay by converting it into a binary image. Using the IoU concept, the calculation results are presented in Table 2.

Table 2. IoU results at out\_cipali\_1.avi sampling

File (jpg)	Pixels				Acc. (%)
	Ground truth	Overlay	I	U	
cip1_1	2533317	2515659	2513643	2535804	99.13
cip1_2.	2540178	2513103	2510268	2543418	98.70
cip1_3	2528508	2526459	2521524	2533950	99.51
cip1_4	2539005	2541966	2533461	2548011	99.43
cip1_5	2534217	2542419	2532423	2544753	99.52
cip1_6	2531979	2540454	2530188	2542938	99.50
cip1_7	2538501	2547894	2537082	2550033	99.49
cip1_8	2535918	2540868	2533554	2544027	99.59
cip1_9	2531421	2535081	2528382	2538804	99.59
cip1_10	2531328	2542950	2529486	2545323	99.38
Avg. Acc.				99.38	

The same process is carried out on the next output video, there are out\_cipali2.avi, out\_cipali3.avi, out\_palikanci1.avi, out\_palikanci2.avi and out\_palikanci3.avi the results are presented in Table 3.

Table 3. accuracy calculation results on sampling result on six video outputs

Output video	Acc.
out_cipali_1.avi	99.38 %
out_cipali_2.avi	99.00 %
out_cipali_3.avi	99.00 %
out_palikanci_1.avi	99.45 %
out_palikanci_2.avi	99.35 %
out_palikanci_3.avi	99.30 %
<b>Average accuracy</b>	<b>99.25 %</b>

The computation time is depicted on Figure 14. The average processing time is 18.01 millisecond/frame. The algorithm is executed by using a personal computer. The computer specification are as follows: 11th Gen Intel(R) Core(TM) i7-1165G7 @ 2.80 GHz processor, RAM 8 GB, and HDD 500 GB. The algorithm can complete the process at a rate of 18.01 milliseconds/frame. Meanwhile, the camera speed is set at 30 frames/second. By applying this speed, a new frame will be generated after 33,33 milliseconds. Since the processing time (0.018) is less than generated frame duration (0.033), then the process will be completed before a new frame appears. This condition can ensure the processing of lines detection can be completed in real-time.

When compared with the results obtained by other authors, using Adaptive Threshold Segmentation of Lane Gradient Image obtained accuracy 91,7% to 97,4% [3]; using Randomized Hough Transform produce accuracy 93.6 % to 95.2% [4]. Comparison of accuracy can be seen in Table 4.

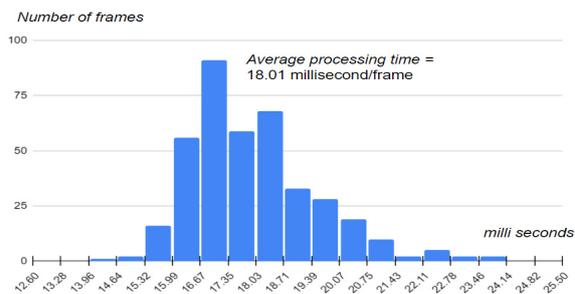


Figure 13. Processing time

Table 4. Comparison of lane detection methods

No	Author, Year	Data	Method	Accuracy
1	Li-Yong <i>et al.</i> [3], 2018	The Hough transform Washington City lane data sets, R G B , Dashboard view	and Kalman filter	91.7 -97.4 %
2	Peerawat <i>et al.</i> [4], 2018	R G B , Dashboard view	Randomized Hough transform	93.6 – 95.2 %
3	Our method	R G B , Dashboard view	Color filtering and Hough transform	99.25 %

#### 4. Conclusion

Driving lane detection is the primary and most important part of the driver guidance system or autonomous vehicle system. This paper describes how to build a driving lane detection system for highway in Indonesia. Based on the test results and accuracy calculations, our method can detect driving lanes. The average value of accuracy is 99.25%. The problem occurs determines the lower and upper thresholds of the white and yellow filters. Sometimes there are sections of highway that do not fit this filter. Some sections of highway require slightly different filter values, possibly due to faded road markings. Also the influence of weather and light exposure. Thus, in the next research is how to make this white and yellow filter adapt to the above conditions, combined with adaptive ROI.

#### Acknowledgement

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# Design of Dental Disease Knowledge Base Editor Dialog using ISR-Framework

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**Abstract**-Dental disease is one of the health problems commonly found in Indonesia. Data from the Indonesian Health Authority indicates an imbalance between the number of handled dental cases and the number of dental specialists who treat them. Technological advances bring significant improvements in the quality of medical services. A reliable Group Decision Support System (GDSS) requires a knowledge base editor for expert knowledge acquisition. A critical aspect in building a knowledge base is the interactive interface design. The problem that often arises is that experts find it hard to use a system because the interface does not meet their expectations. In this study, we analyze the interface requirements for a knowledge base editor with a group of experts. The purpose is to report on the process of designing a knowledge base editor interface with a user-centered expert group using the Information Systems Research (ISR-Framework) framework. We conducted several Focus Group Discussions involving 20 dentists, one dental specialist, and one Information Technology Expert in the GDSS field. The repetitive characteristics of this method help increase the value of user satisfaction. The research results expectedly support the ISR framework as a guide for designing future knowledge acquisition applications.

**Keywords:** Knowledge Base Interface, Dental Diseases, Information Systems Research Framework

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## 1. Introduction

Dental disease is one of the most common health problems experienced by people in Indonesia [1]. Based on the results of the Basic Health Research (Riskesdas) of the Indonesian Ministry of Health in 2018, 57.6% of the Indonesian population experienced dental and oral problems. In addition, 93% of early childhood in the range of 5 - 6 years experience cavities [2]. Furthermore, based on data [3], the most common diseases suffered by the elderly are hypertension 63.5%, dental problems 53.6%, joint disease 18%, oral problems 17%, diabetes mellitus 5.7%, heart disease 4.5%, stroke 4.4%, kidney failure 0.8% and 0.4% cancer. This puts dental health problems in second place and oral health problems in fourth. The high number of dental and oral disease cases in Indonesia is not directly proportional to the number of available dentists. Based on data from the Agency for the Development and Empowerment of Health Human Resources [3], the number of specialist doctors in hospitals in Indonesia in 2018 was 66,691 people with the highest proportion being basic specialists (39.4%) and the least

proportion being specialist dentists. (3.7%). This shows that there is an imbalance in handling between the number of cases of dental problems and the number of specialist dentists who treat them.

Information technology intervention can be a solution to improve the quality of medical services. Human knowledge is captured in computers to solve problems that usually require expert expertise [5]. By utilizing relevant information from users and the available knowledge base, computers can make decision recommendations [6]. In the case of knowledge acquisition with expert groups, it is possible to gain different experiences and knowledge in the same application domain. Thus, it is necessary to acquire and integrate diverse knowledge from expert groups when building an effective Group Decision Support System (GDSS).

A reliable GDSS requires a knowledge base editor for expert knowledge acquisition. The presence of an interactive interface design is one of the important aspects in efforts to acquire and integrate knowledge from expert groups to produce a decision. Previous research [7], stated that the success or failure of a system depends more on

the communication and interface capabilities of the system than on processing speed or problem-solving abilities. Most experts are experts in a specific domain. They tend to use computer technology to complete tasks and solve problems in their work. The user interface has an influence on the ease of use of the system by doctors [4]. In practice, the problem that often occurs is that users have difficulty using the system because the interface that is built is not according to their wishes. A good interface allows an expert to enter his knowledge correctly and more completely. The use of computer-based systems to carry out knowledge acquisition can be a challenge for decision-makers.

This research was conducted to analyze the needs of the knowledge base editor interface with the expert group. The purpose of this study is to report on the process of designing a knowledge base editor interface with a user-centered expert group (User-Centered Design/UCD) using a model called the Information Systems Research framework (ISR-Framework) [8]. This model has not been widely applied to the health application domain compared to other models such as Participatory Design [9]. An important research question [10] was adopted in the analysis process as a guide in developing the interface requirements. In a previous study, [10] stated that human-computer interaction in perspective can be analyzed through 3 questions, namely:

- a. What do users see on the system?
- b. What should the user know about what he sees on the system?
- c. What can users do with the system to achieve the goals of using the system?

These three questions, originally formulated for the design of a Decision Support System (DSS) with a single expert, however, can be applied equally well to the design of a knowledge base editor interface for groups of experts. In its development, several studies were conducted using several tools or methods to carry out the knowledge acquisition process for expert groups such as CADIAG-II/RHEUMA [11] and Word-Net [12]. The interface design developed in this research is based on the Repertory Grid Analysis (RGA) method. RGA is used in this study because it is a technique that is widely used in the knowledge acquisition process [13]. The aim of the study was limited to the design of a knowledge base editor interface for a group of experts in the dental health domain. This study also limits the scope of research carried out by applying RGA to the interface design of the knowledge base editor because in some cases the use of different methods has different interface requirements.

## 2. Related Research

Research related to interface design for knowledge base editors has been carried out by several researchers, including research conducted by [14] that discusses the ideal interface architecture for the knowledge base of expert groups. The

interface consists of two actors, namely the facilitator and the members. The facilitator has an important role in the system to be able to create and manage meeting session details, create a work agenda and set the time for each action and member access rights, manage the details of decision-making activities, group ideas from members, and generate meeting reports. Meanwhile, members can add ideas according to the session, and prioritize ideas by filling out several questionnaires. In addition, members can also add/change resources such as textbooks, videos, journals, etc. Research conducted by [15] describes several design features that can be applied to the knowledge base editor of web contributors using natural language processing using a system called Learner and Learner2. Furthermore, the research conducted [16] investigated whether good information visualization promotes the acquisition of quality from the expert knowledge acquisition process. The results of this study indicate that good information visualization supports the knowledge acquisition process. Concerning appropriate design, this study shows that visualization of information in two dimensions is more suitable to support the knowledge acquisition process than visualization in three dimensions. In addition, this study also confirms that color-coded information visualization slightly improves performance in knowledge acquisition compared to monochromatic.

Research [14], [15], and [16] although focused on designing interfaces for knowledge base editors, did not specifically address the field of dental health. Generally, research related to the dental disease domain focuses on engine inference and knowledge modeling in a knowledge base as in research [34],[35], and [36]. One of the weaknesses that are often encountered in applications or systems is the interface and control of computer systems that do not meet user expectations [30] so that in the end the system cannot be used optimally. A good interface will facilitate communication between the user (who in this case is a specialist dentist) and the computer so that the purpose of developing the system will be achieved. However, there are no studies that focus on discussing this, especially in the field of dental health.

Therefore, based on the studies conducted, there are opportunities to be considered for future research. First, there is currently no common framework that can be used to build knowledge base interfaces with expert groups, particularly in the field of dental health. Most of the knowledge base interfaces reported in the research reviewed are scenario-specific and cannot easily be generalized to other contexts. The next researcher can conduct an analysis related to the mapping of principles that can form a general framework and which can only be applied in certain contexts or systems. Each system has a different character, to some extent, may demand a different design approach. Second, there are very few studies that specialize in the design of knowledge base interfaces for expert groups in the dental disease domain. In fact, in the field of dental health, inflammation of the oral cavity

(oromaxillofacial), for example, can be a complex case and requires the involvement of multiple specialists to treat it [28].

Thus, it is important to present new research to add to the repertoire of GDSS knowledge and technology, especially for groups of dental experts. Therefore, paying attention to this context, this research contributes to providing analysis and provides a framework for building a dental knowledge base interface with expert groups.

### 3. Methods

In this study, the design of the dental disease knowledge base editor interface by an expert group was carried out using the Information Systems Research (ISR) framework [17]. ISR guides the application of user-centered human-computer interaction research methods to identify user needs, and design preferences, and identify barriers or challenges to acceptance of interface design. The stages of the Information Systems Research (ISR) framework are depicted in Figure 1.

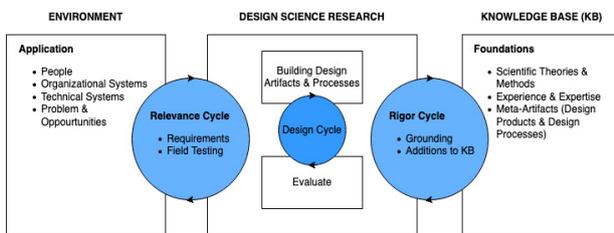


Figure 1. Step of the Information Systems Research framework

In this study, the ISR framework was carried out in 3 cycles, namely: (1) Relevance Cycle or a cycle to understand user behavior and preferences through a series of Focus Group Discussions (FGD) for the Dentist group; (2) Rigor Cycle or cycles to understand user behavior and preferences by conducting studies on theories and artifacts obtained from previous studies and similar applications; (3) The Design Cycle is the design phase that is built and evaluated.

#### a. The Relevance Cycle.

The technique of collecting data using snowball sampling was chosen to obtain dentists who would serve as respondents in this study. The criteria used in the selection of dentists as respondents are dentists who have practiced for at least 5 years, and can use information technology. At this stage, 2 FGD sessions were held involving more than 20 dentists from various regions in Indonesia from May until August 2020 using teleconference media. An overview of the atmosphere of the FGD session can be seen in Figure 2.

The thematic analysis of the FGD sessions revealed three categories of functional requirements [10] including what do users see on the system? what should users know about what they see on the system? and, what can users do with the system to achieve the goal of using the system? Each of these categories of questions was discussed during the FGD sessions with end-users to identify the desired content and functional requirements of the dental disease knowledge base editor interface. The big picture of this stage can be seen in Table 1.

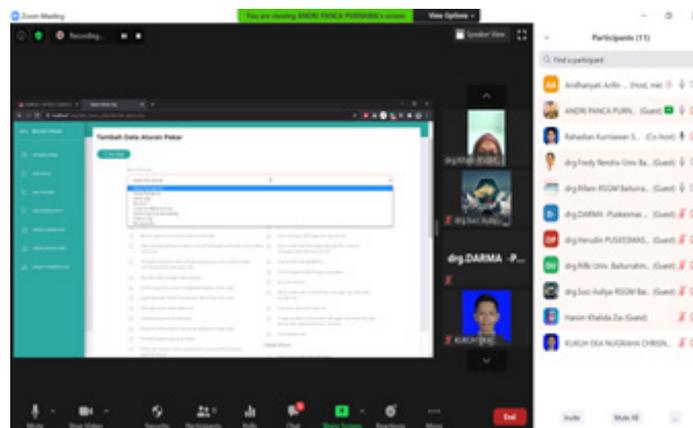


Figure 2. FGD session 1 stage of the Relevance Cycle.

Table 1. Relevance Cycle Results

Functional Requirements	FGD Results
What do users see on the system?	<ol style="list-style-type: none"> <li>1. Want an easy interface with the procedures for establishing a diagnosis.</li> <li>2. The desire for an interface that allows for less scrolling and less writing in one field of view.</li> <li>3. Want an interface that is easy to read, has a consistent organization of information and has an easy flow of information.</li> </ol>
What should the user know about what he sees on the system?	<ol style="list-style-type: none"> <li>1. Symptoms are grouped and written according to the rules of 7 anamneses (The Sacred Seven).</li> <li>2. The doctor wants an alert if the input given has a wide enough range with the average input value of other doctors' trust so that the doctor can check the input given.</li> </ol>

Functional Requirements	FGD Results
What can users do with the system to achieve the goals of using the system?	<ol style="list-style-type: none"> <li>1. Doctors can enter and edit confidence values in each rule.</li> <li>2. Doctors can see the average value of other experts' trust in a rule.</li> <li>3. Doctors can include rules for differential diagnosis, as a comparison to the main diagnosis.</li> </ol>

### b. The Rigor Cycle

This Rigor Cycle stage begins with looking for many previous studies and similar applications related to the research topic and problem domain. Literature from scientific publications that specifically discuss the design of knowledge base editor interfaces for expert groups in the dental disease domain was not found. Therefore, the literature search was extended to the literature with a general discussion but still related to the topic and problem domain. The literature search strategy used consisted of literature sources, restrictions (year of research publication and language of instruction), topic, problem domain, and focus. The year of publication and the language of instruction is not limited to a particular year and language due to the lack of the latest literature that is directly related. The period of the literature obtained is from 1989 to 2018. Literature sources are taken from IEEE, Springer, Google Scholar, Google Book, and Google Patent, both in the form of journals, proceedings, scientific articles, books, and patent documents, on a national and international scale. The total literature obtained is 10 kinds of literature.

1) The results of the literature review are related to the knowledge acquisition process.

According to Dieng et al. [18], the design of a knowledge base for expert groups must take into account the similarities or differences in the domain of expertise of the experts involved and their roles. Experts with the same domain of expertise have the possibility of using different settlement methods. Developers can model more specific pieces of expert knowledge. This is intended to find the possibility of conflict, the possibility of working together and how to reach a consensus or even maintain differences in viewpoints between experts, and how to check the consistency of knowledge. To speed up the process of extracting medical knowledge from dental hygienists, a hybrid method can be used, Zhang et al. [19] divided the procedure into three, namely:

- Collect raw data describing the symptoms and construct the concept of the model. These data were obtained through polls and interviews with patients and dental health experts.
- The expert knowledge acquisition process can be assisted by special tools, namely an object-oriented Knowledge Acquisition (KA) editor and a web-based interface to help collect expert knowledge automatically.
- Dental health experts carry out the process of integrating data and information into a dental health ontology

In addition, semantic web technology can be an approach to the knowledge acquisition process when designing the knowledge base editor Bakraceski et al [20]. The semantics of the web make the editor more understandable to experts because this technology uses a natural language approach so that users can more freely manage data in the way they like.

2) The results of the study of applications in the topic and domain of Health

The process of searching for several applications resulted in several findings:

- Knowledge-Based Electronic Clinical for Dentistry [21]. Many of these applications are equipped with a GUI and the majority adopt the check box and drop list features.
- DDES (Dental Diagnostic Expert System), has a mechanism to collect expert knowledge automatically by providing an object-oriented knowledge acquisition editor. The dialog model used is a windowing system (WS) feature that uses a lot of text input displayed in tables and drop-down scrolls [19].
- CIViC, a knowledge base editor for the clinical interpretation of cancer variants from the expert community, contains an overview of therapies, relevant prognoses, diagnostics, and predisposing conditions of heritable and somatic variants of all types [22]. This application provides a variety of features that can elaborate and validate knowledge from multiple experts in one discipline/domain of expertise or across disciplines. The collaboration model applied is inspired by online collaboration tools such as GitHub and Biostars.

3) The results of the literature review are related to user interface design.

Many types of dialog style models can be used in the design of the knowledge base editor interface, including Graphical User Interfaces or GUI, Windowing System (WS), Icon-based system (IBS), System menu (SM), Form-Filling Dialog (FFD), and Natural Language Processing (NLP) [23].

Based on the results of a study of several kinds of literature, the following recommendations are given:

- Experts in the field of dental health have long and busy working hours. Therefore, the interface design must pay attention to the user's character and efficiency [24].
- The more dominant/preferred types of dialog style models are the System Menu (SM), especially in the

check box and drop list features, Windowing System (WS), Form-Filling Dialog (FFD), and Icon-Based System (IBS) [21], [23]. Text entry is still required in some cases.

- The interface needs to be equipped with a GUI because the existence of this GUI feature has received great acceptance from users. After all, it is more attractive and user-friendly [21], [23]. The GUI features in the editor used by many experts need to pay attention to aspects that represent the user, for example, two-dimensional icons (images) or one-dimensional usernames (plain text usernames) [25].
- Efforts to manage the knowledge of expert groups need to be facilitated by several supporting features such as [22], [26], [27]:
  - o Typeahead suggestions or autocomplete, i.e. recommendations to users appear immediately when the user writes the text.
  - o Automatic warning of possible duplicates
  - o Detailed documentation in all entry forms
  - o Validation of inputs and a mechanism for checking the correctness of the reasoning rules in the knowledge base
  - o Advanced search feature
  - o Group Forum feature provides discussion facilities between experts, which is equipped with information on discussion themes, discussion dates, and times
- The interface needs to be equipped with a GUI because the existence of this GUI feature has received great acceptance from users. After all, it is more attractive and user-friendly [21], [23]. The GUI features in the editor used by many experts need to pay attention to aspects that represent the user, for example, two-dimensional icons (images) or one-dimensional usernames (plain text usernames) [25].

Based on the Rigor Cycle, it is known that most studies are carried out in the context of a single expert or in the same domain, and very few are conducted in the context of groups of experts in different domains (multi-specialist). The context of expert groups in different domains (multi-specialist) is considered more challenging because the actors involved are more heterogeneous and the boundaries between them are often blurred [29]. There are different characteristics to some extent when developing interface designs with groups of experts in different domains. Therefore, paying attention to this context is important and interesting for future research.

### c. The Design Cycle

The purpose of the design cycle is to follow up on the findings from the Relevance Cycle and Rigor Cycle and refine the design to increase the likelihood of technology acceptance. At this stage, two design sessions were conducted for the knowledge base editor with an expert group (Develop/Build and Evaluate).

Each successive design session is based on what was learned from the previous session. Design sessions are an iterative process in which expert respondents provide feedback on the interface, provide ideas on the design, and explain aspects of the interface, and functions that they consider important.

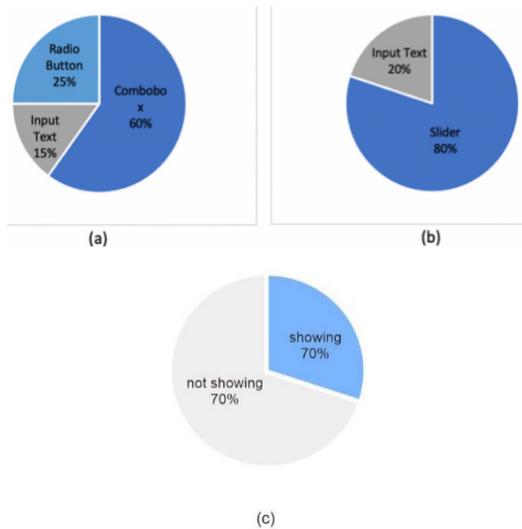
#### 1) Building Design

Design Phase 1. At this stage, the design of the various dialog editors of the dental disease knowledge base was developed by the expert group from the results of the Relevance and Rigor Cycle processes that had been carried out previously. In addition, in this phase, several inputs were also explored through questionnaires to the same respondents at the Relevance Cycle stage related to interface requirements, namely: Presentation of Symptom Input Forms, Input of certainty values from experts, and display of GDSS results.

Figure 3 shows the results of the poll conducted. In the presentation feature of symptom input in the knowledge base, 60% chose to use a combo box with a search feature, 15% chose text input with natural language recognition, and 25% chose to use a radio button (Figure 3a). According to respondents, using a combo box with a search feature based on the text entered by an expert can help the data input process to be faster. Furthermore, there is a recommendation that the name of the symptom must pay attention to the 7 pearl history rules (The Sacred Seven) so that doctors can easily find the symptom in question. For the value feature of expert confidence in the emergence of hypotheses due to evidence, 80% chose the form of a slider, and 20% chose the form of text input (Figure 3b).

Based on the recommendation of a specialist dentist, the display to determine the certainty value is indeed better in the form of a slider which also displays the numerical value. Doctors feel more confident using a slider than entering numbers directly. Furthermore, in the display feature of the GDSS results, 70% of respondents feel that they do not need to display the average value entered by other experts, and 30% feel the need to know the average value of certainty entered by other experts. In this case, the specialist feels that it is not necessary to know the certainty value entered by another specialist, but in certain cases, the expert states that the presence of an average value can give an idea if it is not his domain of expertise (Figure 3c).

Design Phase 2. At this stage, improvements are made to the design of various dialog styles from the results of the evaluation carried out. At this stage, we also conducted interviews with a Specialist Dentist and a Technologist. Information that specializes in the field of GDSS development. In general, the system is considered to meet the needs of experts, but several recommendations are quite important to add, namely the existence of a menu to add rules for comparative diagnosis.



**Figure 3. Needs Features of the Dental Disease Knowledge base editor: (a) Presentation of symptom input in the knowledge base; (b) input of certainty value from expert; (c) GDSS Result Display.**

## 2) Evaluation

The evaluation process was carried out 2 times, namely: Evaluation of building design phase 1, and Evaluation of building design phase 2. The evaluation involved 20 Dentists, as well as 2 experts consisting of 1 expert in the field of information technology who specializes in the development of Group Decision Support Systems, and a Specialist Dentist who is accustomed to using information technology. Each phase is assessed using a questionnaire to evaluate several criteria. The User Interface Satisfaction Questionnaire from Chin [32] was adapted to evaluate the user interface. To evaluate the user interface, 4 questions in the Screen section are given to the user. The question variables are explained as follows:

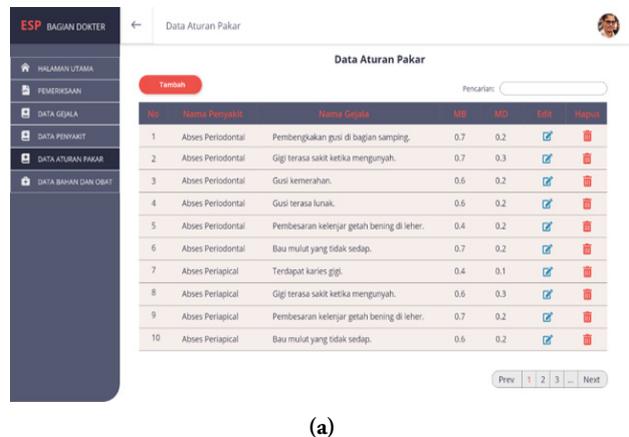
- On-Screen Character Reading (score: 1 = difficult... 9 = easy).
- Task Simplification Highlights (score: 1 = none .... 9 = very much)
- Information Organization (score: 1 = confusing .... 9 = clear)
- Order of the process (score: 1 = confusing ..... 9 = easy)

## 4. Results and Discussion

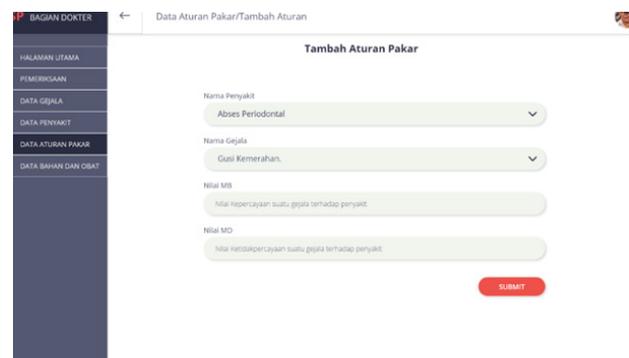
The results of the various dialog designs of the dental disease knowledge base editor using the ISR Framework have been successfully created with several different display models.

Figure 4 shows an image of the interface of the knowledge base editor with a group of experts in the early version of dental disease. The interface design has included features that accommodate knowledge base reasoning using the Certainty Factor (CF) method, which is filled in by the expert along with the rules. The CF filled in by the expert describes the expert's belief in the relationship

between the antecedent and the consequent on the rules of production rules [37]. For example, on the Add Expert Rules page, input facilities are provided for MD (a measure of increased disbelief) and MB (a measure of increased belief) values.



(a)



(b)

**Figure 4. (a) Early version rules interface, (b) Early version add rules interface**

However, the use of MD and MB labels as shown in Figures 4. (a) and 4(b) cannot be understood by the user. In addition, in the interface design, add rules as shown in Figure 4. (b), filling in the MD and MB values using the text field feature, thus confusing the dentists as to what exactly the value should be, whether it is an integer, a fraction of a percentage.

Figure 5 shows an image of the interface of the knowledge base editor with the expert group in the final version of the dental disease domain. Based on the inputs given by the experts in the FGD session, a significant change to the final version of the rule base interface design, one of which is the improvement of label names. As shown in Figure 5. (a), the fourth column label changed its name using user-friendly diction to "certainty value" and the fifth column label changed its name to "uncertainty value".

Changes to the interface design added to the final version of the rules are the use of the slider feature that replaces the text field feature. The display to determine the certainty value is indeed better in the form of a slider which also displays the numerical value. This slider feature shows how much confidence or level of confidence the

doctor has in the symptoms of a disease. Doctors feel more confident using a slider than entering numbers directly. The dialog model using this slider is an implementation of the knowledge acquisition design for many experts using the Repertory Grid Analysis (RGA) method [31]. After the expert identifies the symptoms and diseases, then the expert provides a grid rating using the slider feature. This slider feature is more user-friendly than the check box and text field features. These changes can be seen in Figure 5. (b).

No	Nama Penyakit	Nama Gejala	Nilai Kepastian	Nilai Ketidaktepatan	Ubah	Hapus
1	Abces Perioral	Pembengkakan gusi di bagian samping disertai nanah	0.7	0.2	✎	🗑
2	Abces Perioral	Gigi terasa sakit ketika mengunyah dan timbul rasa nyeri	0.7	0.2	✎	🗑
3	Abces Perioral	Gusi kemerahan	0.6	0.2	✎	🗑
4	Abces Perioral	Gusi Terasa Lunak	0.6	0.2	✎	🗑
5	Abces Perioral	Pembesaran kelenjar getah bening di leher	0.4	0.1	✎	🗑
6	Abces Perioral	Ibu mulut yang tidak sedap	0.4	0.2	✎	🗑
7	Abces Perioral	Demam dan merasa tidak enak badan	0.4	0.1	✎	🗑
8	Abces Perioral	Sakit satu gigi yang terlibat mengalami kegoyangan	0.6	0.4	✎	🗑
9	Abces Perioral	Terdapat karies gigi	0.7	0.3	✎	🗑
10	Abces Perioral	Gigi terasa sakit ketika mengunyah dan timbul rasa nyeri	0.6	0.2	✎	🗑

(a)

Tambah Data Aturan Pakar

Nama Penyakit:

Gejala Bagian Gigi:

Gejala Bagian Gusi:

Gejala Umum:

Nilai Kepastian:

Nilai Ketidaktepatan:

(b)

Figure 5. (a) Final version rules interface, (b) Final version add rules interface

Figure 6 shows the average value of each survey component. On-screen character reading resulted in the highest score among all components with a score of 7.6 out of 9. The design produced in the final stage succeeded in increasing the comfort of reading characters on the screen by increasing the font size and reducing on-screen information to reduce stress on character reading. The increase in user convenience by increasing the font size and reducing the information is in line with research conducted by [33].

The value of organizing information got a score of 7.4 out of 9. This satisfaction value increased quite significantly, amounting to 0.6 from the previous score in the first interface design. This can be achieved through rearrangement of the information presented in each menu

window by adopting the principles of User Center Design (UCD) for the dialog windowing system (WS) model as proposed in research [21] and [22].

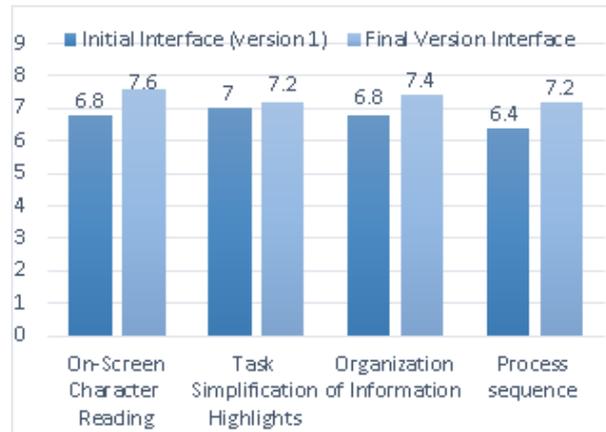


Figure 6. User Interface Design Evaluation Results

The lowest score was obtained from the process flow aspect, namely 7.2 out of 9. Even though it got the lowest score, there was a significant increase in the score, namely 0.8 compared to the first interface design. This increase in value occurred after several streams of expert knowledge management were simplified, for example by changing the value input feature from a text field to a slider and adding a comparative diagnosis menu. It can be concluded that in general the process flow can still be followed by users. In addition, previously in the interview phase with experts and FGD with dentists, it was confirmed that the process flow in the system was following the flow of dental disease diagnosis.

The next lowest score was 7.2 out of 9, the score was obtained from the highlight of task simplification. Not too significant increase in the value of the final design, which is only as much as 0.2 points. If you look back at Figure 5, you can see a comparison of the level of satisfaction between the first design and the final design. That the task simplification aspect in the first interface design has received the best level of satisfaction compared to other aspects (score 7, while others are below 7).

The score from the aspect of highlighting the simplification of tasks with a not-so-significant increase in grades cannot be considered as something bad. In the interview sessions with experts and FGDs with dentists, they felt that the first version of the dental disease knowledge base interface design for the expert group had been able to help them simplify the tasks of a dentist, namely that there were already menus or features that automate their work. experts/dentists, such as checklist menus and combo boxes, then in the final design version a slider feature was added.

In addition, referring to the recommendations from the Rigor Cycle phase, the typeahead suggestion feature is applied when the expert will enter or search for symptoms

and diseases. The error notification feature is also very helpful for experts to prevent them from misbehaving. This change is in line with research [24] that interface design must pay attention to user characteristics and efficiency.

The results of the evaluation show one weakness, the existence of a system workflow that does not fully accommodate the wishes of experts as decision-makers. One of the reasons is that in the implementation of Information Technology applications, there will indeed be an adjustment of the workflow which was originally done manually to be assisted by Information Technology, so it requires time and routine use.

Therefore, based on the results of the interface evaluation, the design in the second cycle was preferred by dentists. This shows that the final design has a more attractive design and is more comfortable for users to use. Repeated characters in the ISR framework can help increase user satisfaction scores.

## 5. Conclusion

The use of the ISR framework in designing a variety of dental disease knowledge base editor dialog is considered time-consuming and expensive to implement. However, the development of interfaces with this framework has proven to be able to produce a technology that is acceptable to users and easy to use. The repeated characteristics of this method help increase the value of user satisfaction in the user evaluation process. Based on the results of the research that has been carried out, this framework can be used as a useful model to guide the development of knowledge acquisition applications in the future.

Another contribution of this research is that the results of the Rigor Cycle stage that have been carried out can map out two studies that can be carried out in the future where future researchers can conduct analysis related to mapping principles that can form a general framework and which can be applied in the context of knowledge acquisition, as well as there is a need for future research related to the analysis of knowledge base editor interfaces in the context of expert groups in different domains (multi-specialist).

This study has several limitations. The data collection is carried out on dentists who are accustomed to interacting with information technology. In some cases, this cannot be generalized to general dentistry. Very little feedback was received from respondents, this could be because the dentist did not fully understand what was being developed. Furthermore, data collection at the Rigor Cycle stage received only a few studies that could be used to enrich the interface design of the knowledge base editor with a group of experts in the dental disease domain.

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