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## **PREFACE**

Editor of TECHNO(Journal of Computing and Information Technology), said praise and gratitude to the presence of Allah S.W.T, creator of the universe who mastered knowledge as wide as heaven and earth, for the abundance of grace and gifts that have been given to TECHNO editors to publish TECHNO Vol. 19, No. 2 September 2022, which is used by lecturers, researching, and professionals as a medium or media to publish publications on the findings of research conducted in each semester.

TECHNO is published 1 (one) year for 2 (two) times at the end of each semester, TECHNO editors receive scientific articles from the results of research, reports / case studies, information technology studies, and information systems, which are oriented to the latest in science and information technology in order to be a source of scientific information that is able to contribute to the increasingly complex development of information technology.

The editor invited fellow researchers, scientists from various tertiary institutions to make scientific contributions, both in the form of research results and scientific studies in the fields of management, education, and information technology. The editors really expect input from readers, information technology professionals, or those related to publishing, for the sake of increasing the quality of journals as we all hope.

The editor hopes that the scientific articles contained in the TECHNO scientific journal will be useful for academics and professionals working in the world of management, education, and information technology

Chief Editor



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## CLASSIFICATION OF STUNTING STATUS IN TODDLERS USING NAIVE BAYES METHOD IN THE CITY OF MADIUN BASED ON WEBSITE

Ari joko Purnomo<sup>1</sup>; Abdul Rozaq<sup>2\*</sup>

Teknik Informatika  
Universitas PGRI Madiun  
<https://unipma.ac.id>  
arijoko527@gmail.com <sup>1</sup>; rozaq@gmail.com <sup>2\*</sup>



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**Abstract**— Stunting in toddlers is a chronic nutritional problem that is being experienced by the health world. Children with stunting have a tendency to decrease their level of intelligence, have speech disorders and have difficulty capturing learning in the usual method. Madiun City still faces challenges in stunting nutrition problems. The prevalence of stunting in 2020 is 10.18 percent or 814 children out of a total of 7,996 measured. The use of data mining can be used in various fields related to large data sets. There are several techniques of working on data mining in retrieval of information, including classification. Generally, the classification of stunting status uses the TB/U index or height compared to age. In this study, the method used is the naive bayes method, which is the method used to predict probability based, the system is built using the python programming language and flask as the framework. The results of the tests carried out show that the naive bayes method can be used in classifying stunting status in toddlers. The Naïve Bayes algorithm implemented has an average performance value of 58% accuracy, 68% precision, and 58% recall from the results of the confusion matrix test with 30% testing data and 70% training data.

**Keywords:** Classification, Naïve Bayes, Data Mining, Stunting, Python.

**Intisari**— Stunting pada balita merupakan masalah gizi kronis yang sedang dialami dunia kesehatan. Anak dengan kondisi stunting mengalami kecenderungan penurunan tingkat kecerdasan, gangguan berbicara dan kesulitan dalam menangkap pembelajaran dalam metode yang biasa. Kota Madiun masih menghadapi tantangan dalam permasalahan gizi stunting. Prevalensi angka stunting tahun 2020 sebesar 10,18 persen atau 814 anak dari total 7.996 yang diukur. Penggunaan data

mining dapat digunakan dalam berbagai bidang yang berhubungan dengan sekumpulan data yang banyak. Terdapat beberapa teknik pengerjaan data mining dalam pengambilan suatu informasi, diantaranya adalah klasifikasi. Umumnya klasifikasi status stunting menggunakan indeks TB/U atau tinggi badan dibanding usia. Pada penelitian ini, metode yang digunakan adalah metode naive bayes, yakni metode yang digunakan untuk memprediksi berbasis probabilitas, sistem yang dibangun menggunakan bahasa pemrograman python dan flask sebagai framework-nya. Dari hasil pengujian yang dilakukan menunjukkan bahwa metode naive bayes dapat digunakan dalam melakukan klasifikasi terhadap status stunting pada balita. Algoritma Naïve Bayes yang diimplementasikan ini, memiliki performansi nilai rata-rata yaitu akurasi sebesar 58%, precision sebesar 68%, dan recall sebesar 58% dari hasil pengujian confusion matrix dengan 30% data testing dan 70% data training.

**Kata Kunci:** Klasifikasi, Naïve Bayes, Data Mining, Stunting, Python.

### INTRODUCTION

Stunting in toddlers is a chronic nutritional problem experienced, especially in the world of health. The intelligence level of children with stunting status tends to be lower, has speech disorders, and has difficulty capturing learning in the usual way. Factors that cause stunted growth in children can be caused during pregnancy, childbirth, breastfeeding or during the puerperium as well as the MPASI factor, which is not enough to feed young children. In addition, the hygiene factor in the poor environment can be a trigger for toddlers to get sick easily. Poor parenting is one of the causes of stunted growth. Poor parenting is

often caused by several factors, such as a mother who is too young or a pregnancy factor that is too close together. In this case, the Ministry of Health of the Republic of Indonesia seeks to improve the nutritional status of the community which is one of the priority programs in national health development as stated in the main objectives of the 2015 - 2019 medium-term development plan to reduce the prevalence of stunting in children under five years of age (Prasetya et al., 2020).

Chronic malnutrition during early growth and development with a growth assessment of a high Z-score for age (TB/U) less than -2SD (standard deviation) of the WHO growth standard. Generally, stunting can affect 1 in 4 young children. The short-term effects caused by stunting are delays in speech ability, limitations, motor and cognitive sensor development, infectious diseases to death. The long-term effects include the risk of degenerative diseases such as coronary artery disease, stroke, high blood pressure and diabetes mellitus. In addition, it can reduce work productivity in adulthood (Zeniarta et al., 2020).

Madiun City is still facing challenges in terms of nutrition (stunting). The prevalence of stunting in 2020 reached 10.18 percent of 814 children out of a total of 7,996 measured. The prevalence of children under five in Madiun City is quite low, even below the standard when compared to the results of Risesdas, which is 10.2%.

Data mining is a science that combines machine learning, pattern discovery, statistical calculations, databases and visualization to obtain information from a wide range of data. The use of data mining can be used in various fields related to large data sets. There are several data mining techniques for retrieval of information, including regression, clustering, association and classification. In classification, there are several methods that can be used, one of the methods commonly used is the Naive Bayes algorithm. Naive Bayes method is a simple probabilistic classification method from Bayes theory where classification is carried out through efficient construction of a number of data sets. Naive Bayes assumes that a value based on an input attribute in a shared class is independent of using another attribute value (Ismasari Nawangsih & Setyaningsih, 2020).

Related to the explanation above, the authors conducted a study entitled "Classification of Stunting Status in toddlers using the Naive Bayes method in the city of Madiun based on the website". This system was created in order to assist health workers in knowing the classification of stunting status in Madiun City.

## MATERIALS AND METHODS

### I. Literary studies

There are many case studies regarding stunting prediction. The following are some related studies regarding the prediction of stunting status.

According to (Zeniarta et al., 2020) in his research entitled Application of the Naive Bayes Algorithm and Forward Selection in Classifying Stunting Nutritional Status at Pandanaran Health Center Semarang. The purpose of this study is to optimize the accuracy value of the Naive Bayes classification algorithm by removing inappropriate attributes using the Forward Selection feature. The results of testing the NBC solving procedure without using feature selection are 83.33%, while the performance of the NBC solving procedure using the forward selection method has increased by 2.67% to 86.00%, and the suggestion needed is to do a comparison test of output accuracy using classification algorithm procedures in addition to the Naive Bayes classification procedure are also feature selection methods other than forward selection which may be able to form a better accuracy value.

According to (Prasetya et al., 2020) in his research the Classification of Toddler Stunting Status in Slangit Village Using the K-Nearest Neighbor Method. The purpose of this study is to classify the status of stunting toddlers using the K-Nearest Neighbor method. The study used 300 data to calculate the Euclidean distance and involved age, height and weight parameters. Then the calculation is carried out with the RapidMiner program with the KNN Classification method which produces an accuracy of 98.89% with NORMAL and LESS statuses. It can be concluded that the application of the K-Nearest Neighbor method in classifying the nutritional status of toddlers using the Euclidean distance calculation formulation has a good performance.

Research conducted by (Siregar et al., 2020) The purpose of this study is to facilitate the processing of comment data, so the comment classification process is applied using the Naive Bayes Classifier method to find out whether the comments were positive or negative. The test results on 50 comment data using the Naive Bayes Classifier method resulted that the output accuracy value was 68%.

#### a. Data Mining

The definition of data mining is the extraction of information or patterns of retrieving data that is in the database. Data mining is known as Knowledge Discovery in Database (KDD). (Siregar & Puspabhuana, 2020) defines data mining as a set of techniques that are used automatically for full exploration and leading to complex relationships in datasets. The dataset in question is a set of tabulated

data, and is often implemented in relational database technology. However, data mining techniques can be used in other data representations, such as domains, text, and multimedia.

According to (Yenderizal, 2022) a term used to describe the discovery of knowledge in databases. Data mining is the process of using statistical, mathematical, artificial intelligence and machine learning techniques to identify and extract information and related knowledge from databases.

**b. Classification**

According to (Prasetyo, 2012) classification is a job in assessing data objects to include in certain class categories from a number of existing classes. In classification there are two types of core work carried out, namely the development of a prototype model that is stored as memory and the use of that model in conducting the introduction/classification/prediction of a data object with the aim of knowing in which class the data object is in a stored model.

Classification consists of a two-step process. The first is the training phase, where the classification algorithm is created with the aim of analyzing the training data which is then represented in the form of a classification rule. The second is classification where test data is used to estimate the classification rule. There are several algorithms commonly used in the classification process, including the Naïve Bayes classifier, neural network, statistical analysis, rough sets, support vector machines and many others (Hesananda, 2021).

**c. Naive Bayes Classifier (NBC)**

Bayes theorem is a rule to improve or revise a probability by utilizing more information. This theory was developed by Thomas Bayes (1702-1763). (Daqiqil, 2021) explained that the Naive Bayes Classifier (NBC) is a technique that uses Bayes' theorem in the classification process of data. NBC assumes that the features contained in the data are independent.

According to (Daqiqil, 2021) Bayes' theorem is generally stated as follows:

$$P(H|e) = \frac{P(e|H) \cdot P(H)}{P(e)} \dots\dots\dots(1)$$

Description:

$P(H|e)$  = Possible hypothesis (H) given the evidence (e) observed (Posterior)

$P(e|H)$  = Possible hypothesis (H) given the evidence (e) observed (Posterior)

$P(H)$  = How big is the probability of the hypothesis (H) before observing the evidence (e) (Prior)

$P(e)$  = What is the probability of proof on all hypotheses

**d. Stunting**

Stunting according to (Tanoto Foundation, 2021) ) is a condition of failure to thrive that occurs in toddlers as a result of chronic malnutrition and repeated infections, especially in the First 1000 Days of Life (HPK) period. Physically, stunted children look shorter than their peers. According to (Kementerian Kesehatan Republik Indonesia, 2018) Children are categorized as stunting if their height is below -2 SD (standard deviation) among children their age. Stunting and other nutritional deficiencies that occur in 1,000 HPK do not also cause stunted physical growth and increased susceptibility to disease, but can threaten cognitive development that may affect the current intelligence and productivity of a child in adulthood.

The stunting condition that is often experienced by toddlers as well as children can be caused by several triggering factors, such as maternal nutrition during pregnancy, pain experienced by babies, and lack of nutritional intake in infants to socio-economic conditions of the community. A mother is an important key in the role of determining the development of stunting, considering that the initial development of a child starts from the fetus (Yoto et al., 2020).

**e. Confusion matrix**

The confusion matrix is a matrix of size N x N where N is the number of predicted classes. So this matrix is good when used in classification problems. (Daqiqil, 2021) explaining the Confusion matrix provides a summary of the prediction results that have been generated by comparing the predicted results with the expected results. The confusion matrix table can be seen in Table 1.

Table 1. Table Confusion Matrix

	Actual = Yes	Actual= No
Predicted= Yes	TP	FP
Predicted= No	FN	TN

Source: (Daqiqil, 2021).

Based on the table above, the confusion matrix is described into 2 classes, namely Yes and No. in the confusion matrix table is divided into 4 categories namely True Positive (TP), False positive (FP), False Negative (FN) and True Negative (TN). TP is the number of correct positive data in the classification process, FP is the number of negative data classified into positive values, FN is the number of positive data classified into positive values & TN is the number of negative data classified into negative values.

## II. Research methods

### a. Thinking framework

The type of research used in this study is an experimental research model. This study aims to evaluate the data mining classification algorithm. This experimental research emphasizes on existing theories. In this study, the type of research taken is a comparative experiment based on a problem-solving framework as shown in Figure 1.

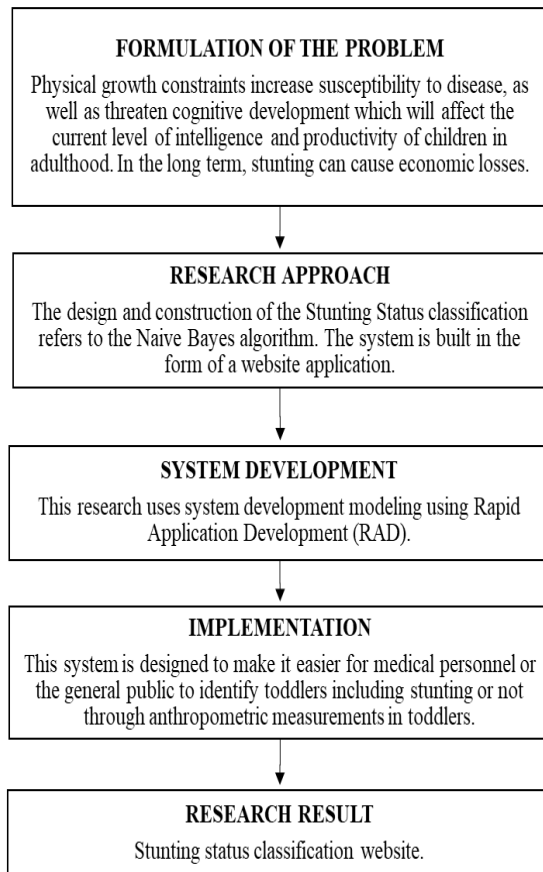


Figure 1. Thinking Framework

The thinking framework of this research begins with the formulation of the stunting status problem which is then made into a model design and system development in the form of a Naive Bayes algorithm to solve the problem.

### b. Research design

The research design used can be seen in Figure 2, as follows:

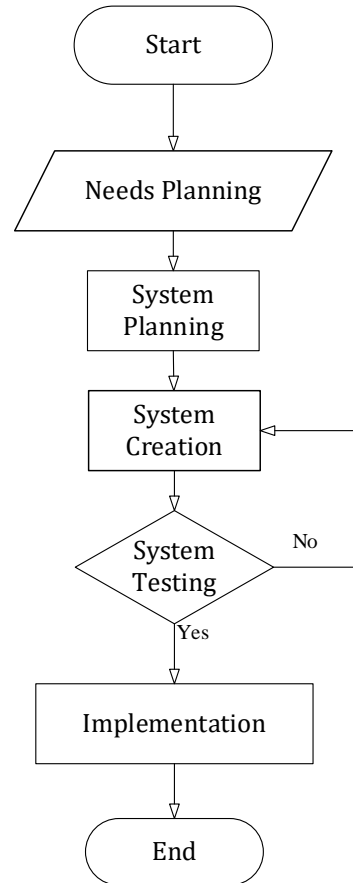


Figure 2. Research Design Flowchart

Description:

#### 1. Needs Planning

This stage is the initial stage, where problem identification is carried out and data collection obtained from users aims to identify the purpose of the system.

#### 2. System Design

At this stage, the system workflow design, system workflow modeling using Unified Modeling Language (UML), calculations using the Naive Bayes algorithm and system User Interface design are carried out.

#### 3. System Creation

At this stage, the program code is written according to the design that has been done. Furthermore, the modules that have been finished are tested whether there are discrepancies in the work.

#### 4. System testing

At this stage the system is tested to ensure the entire workflow of the system works according to its function.

#### 5. Implementation

At this stage the system that has been tested can be implemented by adding hosting so that it gets access to the internet and can be accessed openly.

**RESULTS AND DISCUSSION**

The data used in this study were taken from the Madiun City Health Office. The data is the result of anthropometric measurements of 673 toddlers. From this data, it will be divided into training data and testing data. From the training data, 70% of the total data are taken, namely 471 data, and 30% of the testing data is taken from the total data, namely 202 data. The stunting data consists of 4 attributes, namely gender, age, height, weight and label. As shown in table 2:

Table 2. Toddler Sample Data

No	Gender	Age (month)	Height (cm)	Weight (kg)	Label
1	F	49	95	14.2	Short
2	F	37	89.7	11.6	Normal
3	M	29	80.5	11.7	Very Short
4	M	45	100	15.6	Normal
5	F	11	69	7	Normal
6	F	2	52.9	4.3	Short
7	M	38	90.7	16.5	Normal
8	M	21	80.4	10.2	Normal
9	M	18	79.3	10.3	Normal
10	M	20	85.3	13	Normal
11	M	38	95	14.6	Normal
12	M	38	90.5	19.3	Normal
13	M	30	85	12	Short
14	M	12	76.7	10	Normal
15	M	57	102.5	16	Normal
16	M	6	69	8.5	Normal
17	M	13	76	9.5	Normal
18	M	24	84.2	12.5	Normal
19	M	52	100.6	14.3	Normal
20	M	42	96	14.9	Tall

Source: Dinas kesehatan (2022)

From table 2 above is a sample of stunting status data which then from the 20 samples above will be used in the naive Bayes calculation data, then the next process is to transform or change the data into a form that is more suitable for the data mining process. The data will be converted into a format that can facilitate the process of predicting stunting status. In this case, in classifying stunting status, namely height according to age (TB/U). Transformation category data can be seen in table 3.

Table 3. Transformation Category Data

Category	Description
Age <=16	Age below or equal to 16 months
Age 17-31	Age between 17-31 months
Age >32	Age above 32 months
Height <=50	Height below or equal to 50 cm
Height 51-100	Height between 51-100 cm
Height >100	Height above 100 cm

The target variable or class will be divided into 4 categories, as shown in table 4.

Table 4. Classes

Variable	Description
1	Very Short
2	Short
3	Normal
4	Tall

**1. Naive Bayes Calculation**

The training data is then entered into the naive Bayes algorithm model to produce a stunting status prediction model. To test the naive Bayes algorithm, the testing data is entered into the prediction model. In this calculation, training data will be taken from 20 sample data in table 2 which will then be used to determine the classification of the testing data. Below are the steps for naive Bayes using 1 data testing, namely if gender = male, age = 17-31, height = 51-100.

- 1) It is known that the Label class has 4 classifications, namely:
  - C1 = Diagnosis Result = very short
  - C2 = Diagnosis Result = Short
  - C3 = Diagnosis Result = Normal
  - C4 = Diagnosis Result = Tall
 Calculation:  
 Count the number of classes.  
 The number of each Label class is divided by the total data contained in the training data.  
 $P(Y=Very Short) = 1/20 = 0,05$   
 $P(Y=Short) = 3/20 = 0,15$   
 $P(Y= Normal ) = 16/20 = 0,8$   
 $P(Y=Tall) = 1/20 = 0,05$
- 2) Calculate  $P(X|Ci)$ , which is the probability of each attribute in data X, then divided by the number of class categories.
  - a. Calculating gender class probability
    - $P(\text{gender} = \text{Male} | Y=\text{Very short}) = 1/1 = 1$
    - $P(\text{gender} = \text{Male} | Y=\text{Short}) = 1/3 = 0,333$
    - $P(\text{gender} = \text{Male} | Y= \text{Normal}) = 14/16 = 0,875$
    - $P(\text{gender} = \text{Male} | Y= \text{Tall}) = 1/1 = 1$
  - b. Calculating the probability of an age class
    - $P(\text{Age} = 17-31 | Y=\text{Very short}) = 1/1 = 1$
    - $P(\text{Age} = 17-31 | Y=\text{Short}) = 1/3 = 0,333$
    - $P(\text{Age} = 17-31 | Y= \text{Normal}) = 4/16 = 0,25$
    - $P(\text{Age} = 17-31 | Y= \text{Tall}) = 0/1 = 0$
  - c. Calculating the probability of an age class
    - $P(\text{Height} = 51-100 | Y=\text{Very short}) = 1/1 = 1$
    - $P(\text{Height} = 51-100 | Y=\text{Short}) = 3/3 = 1$
    - $P(\text{Height} = 51-100 | Y= \text{Normal}) = 14/16 = 0,875$
    - $P(\text{Height} = 51-100 | Y= \text{Tall}) = 0/1 = 0$
- 3) Calculate the total value for each attribute in each classification.

$$P(\text{gender} = \text{Male} \mid Y = \text{Very short}) * P(\text{Age} = 17-31 \mid Y = \text{Very short}) * P(\text{Height} = 51-100 \mid Y = \text{Very short})$$

$$= 1 * 1 * 1$$

$$= 1$$

$$P(\text{gender} = \text{Male} \mid Y = \text{Short}) * P(\text{Age} = 17-31 \mid Y = \text{Short}) * P(\text{Height} = 51-100 \mid Y = \text{Short})$$

$$= 0,333 * 0,333 * 1$$

$$= 0,110889$$

$$P(\text{gender} = \text{Male} \mid Y = \text{Normal}) * P(\text{Age} = 17-31 \mid Y = \text{Normal}) * P(\text{Height} = 51-100 \mid Y = \text{Normal})$$

$$= 0,875 * 0,25 * 0,875$$

$$= 0,19140$$

$$P(\text{gender} = \text{Male} \mid Y = \text{Tall}) * P(\text{Age} = 17-31 \mid Y = \text{Tall}) * P(\text{Height} = 51-100 \mid Y = \text{Tall})$$

$$= 1 * 0 * 0$$

$$= 0$$

- 4) Compare each class result in the classification. Based on the test data for which the result class is not known, then calculated using the Naïve Bayes method, the data X = (gender = Male, Age = 17-31, Height = 51-100) produces a very short diagnostic value, namely with a score of that is 1.00.

## 2. Confusion Matrix Calculation

Performance evaluation is carried out using the confusion matrix technique to measure the performance of the data model created. Evaluations carried out using the confusion matrix technique include accuracy, recall precision and f-1 score. The results of the evaluation using the confusion matrix can be seen in Table 5.

Table 5. Confusion Matrix Results

		Predicted Class			
		1	2	3	4
Actual Class	1	40	10	1	0
	2	14	19	21	0
	3	33	5	57	0
	4	1	0	0	1

In table 5, there are actual classes and predicted classes. The actual class is a class whose class/label has been previously determined, while the predicted class is a class that is predicted using the Naive Bayes method.

The results of the calculation of the confusion matrix in the table produce label 1 (very short) there are 40 test data that are classified correctly by the system and 11 data that are classified

incorrectly, while on label 2 (short) there are 19 test data that are classified correctly and 35 data that are classified wrong. label 3 (normal) there are 57 test data that are classified correctly by the system and 38 data that are classified incorrectly, then on label 4 (tall) there is 1 test data that is classified correctly and 1 data that is classified incorrectly

Accuracy, precision, recall and f-1 score are each calculated by the confusion matrix module in the sklearn library using jupyter notebook. The calculation of the value of accuracy, precision, recall and f-1 score can be seen in Table 6.

Table 6. Confusion Matrix Result

Label	precision	recall	f1-score
1	0.45	0.78	0.58
2	0.56	0.35	0.43
3	0.72	0.60	0.66
4	1.00	0.50	0.67
accuracy			0.58
macro avg	0.68	0.56	0.58

In Table 6, the average accuracy value is 0.58 or 58%, the average precision value is 0.68 or 68%, the recall average value is 0.56 or 56% and the average value is 56%. the average f-1 score is 0.58 or 58%.

## 3. System Implementation

The Home page serves as the initial display of the system (dashboard) which contains information such as a navigation bar to carry out the process of moving pages. Then there is speech and information about the classification system as the initial interaction of the system to the user. there is a prediction menu shortcut button that can be classified by the system. The design of the home page can be seen in Figure 3.

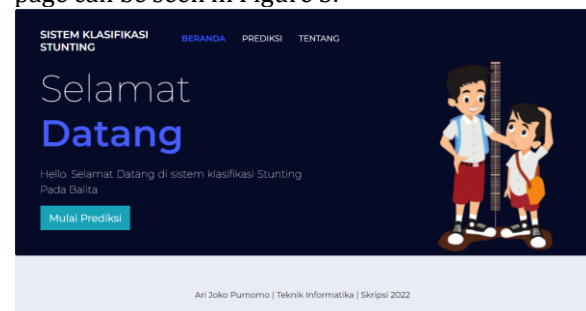


Figure 3. Home page

In the prediction page design, users will be directed to fill out 4 input forms that can be filled with toddler data including gender, age, weight, and height. Then the classification process is carried out on the previously created data model. The prediction process runs by taking data from user data input which is then classified to determine the position of user data belonging to the closest label based on the similarity of the data. The data label

consists of 4 classes, each of which is very short, short, normal, and high. The implementation of the prediction page can be seen in Figure 4.

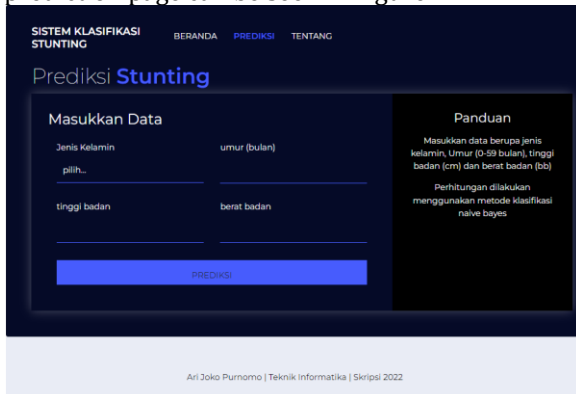


Figure 4. Prediction form page

The prediction results page displays toddler data that is input by the user and has undergone a data classification process. The Stunting data label will appear on the user's screen along with the right solution or steps that the user can take based on the stunting status of toddlers. The implementation of the prediction results page can be seen in Figure 5.

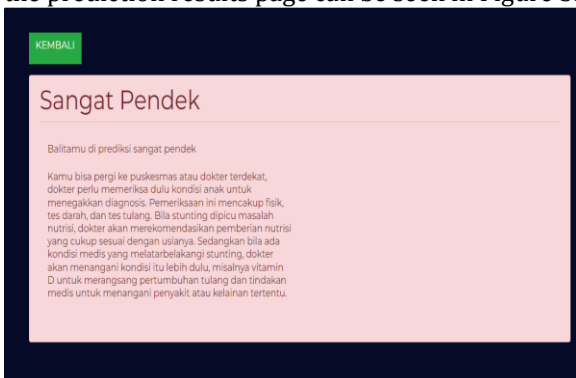


Figure 5. Prediction results page

The guide page contains information about an introduction to stunting and what causes stunting. The implementation of the home page can be seen in Figure 6.



Figure 6. About page

## CONCLUSION

Based on the results of the research that has been done, it can be concluded that the outcome of this study is a classification system for stunting status in toddlers that can be used to assist in identifying stunting status in toddlers. Then the calculation of the performance of the naive Bayes classification data model that is made is calculated using the confusion matrix resulting in an accuracy value of 58%, a precision value of 68% and a recall value of 58%. From the results of the confusion matrix test with 30% testing data and 70% training data.

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## SENTIMENT ANALYSIS FOR PHARMACEUTICAL COMPANY FROM SOCIAL MEDIA USING ADAPTIVE COMPRESSION (ADACOMP) WITH RANDOM UNDER SAMPLE (RUS) AND SYNTHETIC MINORITY OVER-SAMPLING (SMOTE)

Pamungkas Setyo Wibowo<sup>1\*)</sup>; Andry Chowanda<sup>2</sup>

Computer Science Department  
Binus Graduate Program – Master of Computer Science  
Bina Nusantara University, Jakarta, Indonesia, 11380  
pamungkas.wibowo@binus.ac.id <sup>1\*)</sup>, achowanda@binus.edu<sup>2</sup>



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**Abstract**—Pharmaceutical company has become the most highlight company across the world lately because of the pandemic. Despite of the high demand market in pharmaceutical company, about 94% of large company across the world having difficulty in their supply chain that indirectly affect their services. The purpose of this research is to compare word embedding with compression model by doing sentiment analysis about the entity to find the best model that give better accuracy rates based on the opinion of Twitter, Instagram and Youtube, as they are the largest platform that its many users to express their opinions about an individual or an instance. Data is retrieved from Twitter, Instagram and Youtube using the R-Studio application by utilizing their API library, then preprocessing and stored in a database. Next step is labeling the data and then train the data using word2Vec and LSTM, GloVe and LSTM and lastly using Adaptive Compression (adaComp) to compress the both model word embedding. Unfortunately, we got imbalanced dataset after labeling process, so we add sampling technique to sampling the dataset using Random Under Sample (RUS) and Synthetic Minority Over-sampling Technique (SMOTE). After the data are trained and tested, the results will be evaluated using Confusion Matrix to get the best Accuracy. With several models that have been carried out, applying adaComp is proven to increase accuracy. In the Word2Vec word embedding with LSTM model, applying adaComp increasing its accuracy from 77% to 81%.

**Keywords:** Pharmaceutical, Sentiment Analysis, AdaComp, Word2Vec, GloVe.

**Intisari**—Perusahaan farmasi telah menjadi perusahaan yang paling menonjol di seluruh dunia akhir-akhir ini karena pandemi. Meskipun permintaan pasar pada perusahaan farmasi sedang tinggi, sekitar 94% perusahaan besar di seluruh dunia mengalami kesulitan dalam memenuhi rantai pasokan mereka yang secara tidak langsung mempengaruhi layanan mereka. Tujuan dari penelitian ini adalah untuk mengetahui opini publik tentang Entitas Perusahaan Farmasi apakah positif, netral atau negatif dengan melakukan analisis sentimen tentang entitas itu sendiri berdasarkan pendapat Twitter, Instagram dan Youtube, dikarenakan platform tersebut adalah yang memiliki banyak penggunaanya untuk mengekspresikan pendapat mereka tentang individu atau perusahaan. Data diambil dari Twitter, Instagram dan Youtube menggunakan aplikasi R-Studio dengan memanfaatkan library API-nya, kemudian dilakukan preprocessing dan disimpan dalam database. Langkah selanjutnya adalah pelabelan data dan kemudian melatih data menggunakan word2Vec dan LSTM, GloVe dan LSTM dan terakhir adalah mengaplikasikan adaptive compression(adaComp) pada word embedding. Sayangnya, kami mendapatkan dataset yang tidak seimbang setelah proses pelabelan, jadi kami menambahkan teknik sampling untuk mengambil sampel dataset menggunakan Random Under Sample (RUS) dan Synthetic Minority Over-sampling (SMOTE). Setelah data dilatih dan diuji, hasilnya akan dievaluasi menggunakan Confusion Matrix untuk mendapatkan Akurasi terbaik. Dengan beberapa model yang telah dilakukan, penerapan adaComp terbukti meningkatkan akurasi. Pada Word2Vec word embedding dengan model LSTM,

penerapan adaComp meningkatkan akurasi dari 77% menjadi 81%.

**Kata Kunci:** Farmasi, Analisis Sentimen, AdaComp, Word2Vec, GloVe.

## INTRODUCTION

Social media has become our daily needs and cannot be separated from human activity (Fabris et al. 2020). Even in situations of social uncertainty such as lockdown decisions and pandemics, the need for the use of social media is increasing (Størdal et al. 2021). Social media users is 59% of Indonesian Internet users, counting to 160 million Users (Kemp 2020). Some of the platforms that are widely used is Twitter, Instagram and Youtube where the number of users is 27% of the number of social media users in Indonesia (Muhammad, Kusumaningrum, and Wibowo 2021). Nowadays, social media is not only restricted to communicate with its own member but there is some official company that using social media to retrieve feedback from its user (Jiao, Veiga, and Walther 2020; Robiady, Windasari, and Nita 2020).

Sentiment analysis or opinion mining is a process of understanding, extracting and processing textual data automatically to get sentiment information contained in an opinion sentence (Liu, Shin, and Burns 2019). This is important for companies to be able to find out the value of opinions formed on social media (Rasool, Shah, and Islam 2020) so that it is hoped that the company can take the right steps in determining the best strategy. Lately, pharmaceutical companies are experiencing tremendous impact because of the effects of the pandemic as the need for medicine is the priority in every aspect (Prasad and Bodhe 2012). However, in addition to the extraordinary demand for drugs and supplements, many difficulties occurred, especially in the material supply chain for product manufacturing that impact about 94% to large company around the world (Chowdhury et al. 2021). To fulfil this high demand on the market companies need to make extra effort that impact their services to society. For this reason there is high number of public opinion in social media had been created (De, Pandey, and Pal 2020).

The use of deep learning to conduct sentiment analysis can be a solution to these problems (Alam et al. 2020). In previous research sentiment analysis was only carried out on one social media. Meanwhile, according to statistical calculations carried out by statcounters, the status of use of social media in Indonesia is divided into many platforms. Generic word embedding such as GloVe and word2Vec which have been pre-trained have shown tremendous success when used, however there are many applications that use specialized

vocabulary domains and the relatively small amount of data is not optimal (Sarma, Liang, and Sethares 2018).

Topic compression word embedding in sentiment analysis is to compress for each word in word embedding before used for sentiment analysis. For the last five years, many topics about sentiment analysis have been presented and the latest approaches about it is using compression in word embedding to support sentiment analysis. The use of adaptive compression is based on Gumbel-Softmax algorithm (Kim, Kim, and Lee 2020) by changing the concept of word embedding to adaptiv and learns to compress embedding words that take into account the downtime of the task. Yet for this last research is not applied to analysis sentiment, and most of the proposed topic segment in sentiment analysis are used for English language. The most known word embedding to support that are Word2Vec or GloVe which are considered as generic word embedding.

For example, works deal with indonesian sentiment analysis such as the work of Nawangsari et al (Nawangsari, Kusumaningrum, and Wibowo 2019). They conducted a study on word2vec by comparing the existing models and giving the best model result is Skip-Gram with an accuracy rate of 92.377%. On the other hand, Bagheri et al (Bagheri, Saraee, and Jong 2013) conducted a similar research on a dataset of customer reviews of electronic products to determine their value on customer satisfaction. This study give an accuracy value of 84.5% has been obtained and has been effective in seeing the level of customer satisfaction.

Based on these related works in the field of sentiment analysis using compression method, we notice that only single platform social media is used, especially the references of sentiment analysis that use compression method. However, the application of compression with the adaptive model is relatively new research. Previously there had been research related to adaptive compression of word embedding, but in this study the author will apply adaptive word embedding with the Indonesian language corpus with research subjects in pharmaceutical companies. Furthermore, we want to conduct research using various data sources not only from one social media and apply the adaptive compression to the Word2Vec and GloVe models.

Hence in this paper, we will study Word2Vec and GloVe with adaptive compression to determine which one is the most efficient method that give the best improvement in accuracy. Moreover, this study will be done with multi platform social media such as Twitter, Instagram and Youtube to improve the dataset due to pharmaceutical company entities are rarely found on social media. Furthermore we use LSTM processed layer to conduct sentiment

analysis and exploits the bilingual aspect of these methods by focusing on two languages : English and Indonesian.

This paper is organized as follows : Section 2 presents related works in the field of sentiment analysis; Section 3 explain about proposed method and describes Word2Vec, GloVe and Adptive compression (AdaComp); Section 4, experimental result and discussion are reported; The conclusion and future woek are presented in section 5.

### MATERIALS AND METHODS

First, data will be collected on several social media which is Twitter, Youtube and Instagram. The data taken from social media contains the keyword of Entity that used as subject of this study. The process of retrieving data uses the API provided by social media developers and forum developer sites such as developers google and github. After the data is obtained, the data will be stored in the PostgreSQL database.

The data that has been stored in the database is raw data where there are still many invalid words, so pre processing will be carried out to clean the data and will be processed to label per row of data using lexicon, alternatively the data will be labelled manual with subjective appraisal from the annotator. After that the data will be entered in CSV and will be used as a data model for the Train and Test of the Learning algorithm in using several word embedding models compared to one adaptive model.

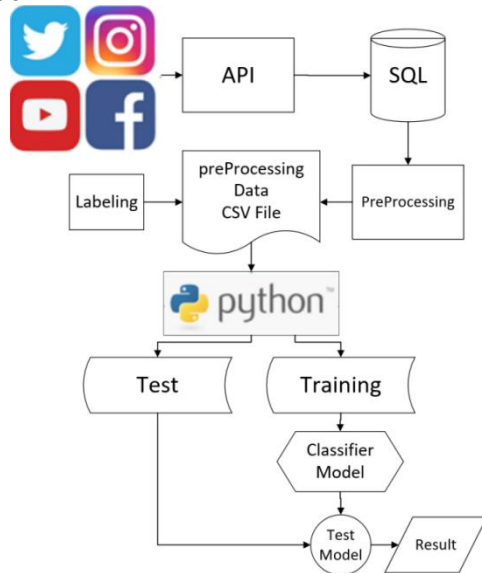


Figure.1 Methodology

#### a. Data Crawling

Data from Twitter will be collected through the Twitter API, Instagram API and Youtube API using R-Studio software. The data collected are about Entity referred by those social media users from

August 1, 2017 to February 15, 2021. After the data is obtained, the data is then stored in the PostgreSQL Database. But not all parts of the data are stored in a database. Information needed for research is as follows:

- ID: The ID for each Tweet, Instagram post and Youtube post that exists, originating from each social media.
- Content: Tweet, Instagram post and Youtube post from Twitter, Instagram and Youtube about Entity.
- Date: The date a post was created

From the data obtained a total of 33,864 data which is a combination of 3 data obtained from 3 annotators into a dataset. The dataset that will be used in this study was built by the author with details of 19,449 data from social media Instagram, 13213 data from social media Twitter and the last 1200 data from social media YouTube.

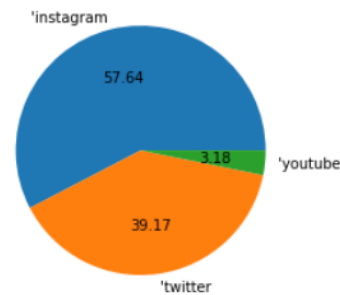


Figure.2 Percentage dataset source

#### b. PreProcessing

PreProcessing is a step to clean up data for sentiment analysis. The first PreProcessing steps is case folding, this step aims to turn all words into lowercase letters. The aim is to avoid case sensitive when matching words with a dictionary. An example is the change in the word 'Slow' to 'slow'. Second, normalization to remove the link in the post on social media, because the link is not part of the analysis. After that, we do data cleansing to removing characters other than letters, such as punctuation and symbols. Then we remove stopwords to eliminate words that are considered to have no meaning. Finally, tokenization is done by separating each word into one separate part. Separation of these words is done by cutting sentences based on spaces so that later can be made a vocabulary based on unique words contained in the text.

### c. Labeling

The labeling process in this study will be done manually using 3 annotators. To find the inter-agreement between the three annotators, the Kappa coefficient is used which is a statistical calculation. The Kappa coefficient value is calculated with an average value of 0.611, where this value indicates a good agreement or has sufficient influence. From the labeling results, the content data on social media labeled Neutral is 27,815, Positive is 5,443 and Negative is 606. The results of the labeling carried out look unbalanced between Positive and Negative Neutrals, where the neutral sentiment value is much higher up to 82.07%, while for the positive it is 16.13% and for the negative it is 1.80%. For this reason, in this study, data sampling will be carried out using the Random UnderSample (RUS) technique and the Synthetic Minority Over-sampling Technique (SMOTE). Random under sample is used to balance the abundant class, while SMOTE is used to increase the missing data. The use of these two data sampling is very important to eliminate over fitting results so that the accuracy value obtained is maximized. After sampling the data, the results obtained for a neutral value of 27815, positive of 18046 and negative of 10866.

### d. Word2Vec

Word2Vec is a model name word vector representation made by Google that can represent the meaning of a word and can measure several vectors as a comparison(Sung et al. 2020). In this research, text data that has been pre-processed is processed using the Embedding Layer on Word2Vec with the English and Indonesian language corpus obtained from the nlp vector site repository. After processing and obtaining the vector of the sentence, the data will be processed using LSTM so that the score and accuracy can be searched(El-diraby, Shalaby, and Hosseini 2019; Rojas-Barahona 2016).

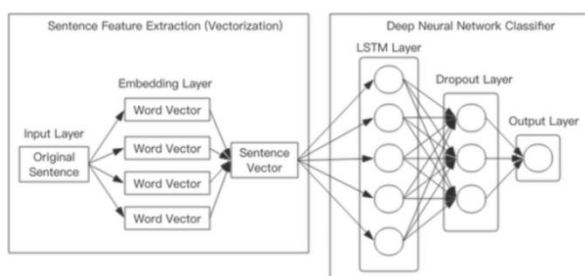


Figure.3 Word2Vec Architecture with LSTM Model

Word2Vec generates a vector space obtained from the corpus, which consists of words that are similar in the corpus and adjacent to each other in the Word2Vec space(Nawangarsi et al. 2019). The main principle of this method is to study the laws of dimensional vectors, where Word2Vec can predict words based on their context using one of 2 different neural models namely CBOW and Skip-Gram. Continuous bag of words (CBOW) predicts the current word based on its context. In the CBOW process, three layers are used. Input layer according to the context. The hidden layer corresponds to the projection of each word from the input layer into the weight matrix which is projected to the third layer which is the output layer. The final step of this model is a comparison between the output and the word itself to correct its representation based on the back-propagation of the error gradient(Naili et al. 2017). The process in CBOW can be described by the following equation :

$$\frac{1}{V} \sum_{t=1}^V = \log p(m_1 | m_{t-\frac{c}{2}} \dots m_{t-\frac{c}{2}}) \dots \dots \dots (1)$$

Skip-Gram is the opposite of CBOW where Skip-Gram looks for context prediction given a word, not word prediction given context like CBOW. The process of Skip-Gram can be described by the following equation:

$$\frac{1}{V} \sum_{t=1}^V = \sum_{j=t-c, j \neq t}^{t+c} \log p(m_j | m_t) \dots \dots \dots (2)$$

where V corresponds to vocabulary size, c corresponds to the window size of each word.

### e. GloVe

The GloVe algorithm is an extension or extension of the word2vec method for efficiency in word vector learning that works by capturing global statistics and local statistics from a corpus. GloVe is an unsupervised learning method to get vector representations for words. Training or training is carried out on globally aggregated words collected from the corpus and the resulting representation displays the linear structure of the word vector space. In this research text data that has been pre-processed is processed using Word Embedding on GloVe. Then the data will be processed using LSTM so that the score and accuracy can be searched(Rojas-Barahona 2016; Song, Park, and Shin 2019).

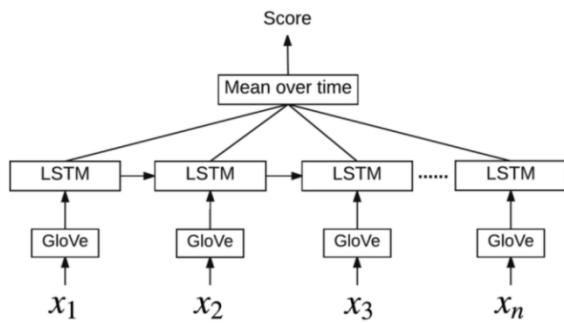


Figure.4 GloVe Architecture with LSTM model

GloVe is an unsupervised learning method for obtaining vector representations for words. Training or training is carried out on global aggregated words collected from the corpus and the resulting representation displays the linear structure of the word vector space. Due to the high quality of textual features, GloVe embedding has been widely used for text mining or natural language processing tasks (Sakketou and Ampazis 2020). In his research, (Levy, Goldberg, and Dagan 2015) stated that there are 2 stages in the GloVe process. The first is the matrix construction of occurrence of X from the training corpus where  $X_{ij}$  is the frequency of the word  $i$  that occurs together with the word  $j$ .  $X_{ij} = \sum_k^V X_{ik}$  is the number of occurrences of the word  $i$  in the corpus. The second step is to factor X to get a vector, with the following equation :

$$F(W_i - W_j, W_k) = \frac{P_{ik}}{P_{jk}} \dots \dots \dots (3)$$

Where  $W_i, W_j$  and  $W_k$  are three vector words,  $P_{ik} = X_{ik}/X_i$  is the probability of the word  $k$  appearing in the context of the word  $i$ ,  $w$  is the word vector and  $W_k$  is the context word vector.

**f. AdaComp**

AdaComp is a compression technique that can be used for word embedding (Li et al. 2021; May and Labs 2008). AdaComp is based on localized gradient residual selection and automatically adjusts compression level depending on local activity (Kim et al. 2020). AdaComp adaptively adjusts compression ratios across various mini-batches, epochs, network layers, and bins. This characteristic provides automatic adjustment of the compression ratio, resulting in strong model convergence. This technique works in several stages, the first is to find the maximum residual value in each bin. Furthermore, quantitation of the compressed residual vector is carried out to increase the overall compression rate. AdaComp is applied to each layer separately. In this research, text data that has been pre-processed is processed using the Embedding

Layer on Word2Vec with the Indonesian language corpus obtained from the nlp1 vector site repository. The data that has been processed will be compressed and decompressed so that it can be continued for learning and calculating the accuracy value.

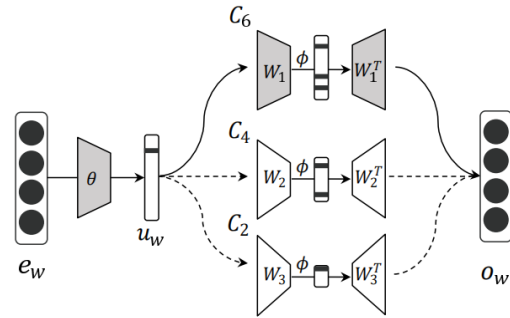


Figure.5 Adaptive Compression with LSTM Model

a. Evaluation Method

The evaluation method used in this study is the Confusion Matrix which aims to obtain the accuracy, precision, recall and F-Score values of the models that have been made. Accuracy is the most commonly used evaluation method. Accuracy obtained is the percentage of identified data compared to the sum of all data (Sindhu and Vadivu 2020). The accuracy obtained is the percentage of identified data compared to the sum of all data, to determine the accuracy the following formula is used.

$$Accuracy = \frac{TP + TN}{TP + TN + FP + FN} \dots \dots \dots (4)$$

$$Precision = \frac{TP}{TP + FP} \dots \dots \dots (5)$$

$$Recall = \frac{TP}{TP + FN} \dots \dots \dots (6)$$

$$F - Score = \frac{2(Precision * Recall)}{(Precision + Recall)} \dots \dots \dots (7)$$

**RESULTS AND DISCUSSION**

To determine which method of Word2Vec and GloVe with adaptive compression (AdaComp) is better to improve the accuracy, we conduct research with 4 different models. The model consist of Word2vec model architecture, GloVe model architecture, Word2Vec with AdaComp model architecture and GloVe with AdaComp model architecture. This experimental study employs 3

social media dataset in the English and Indonesian language as data in the amount of 33,864 data combination. The details of the data distribution after sampling data were 18046 positive labelled review data, 10886 negative labelled data and 27815 neutral data as depicted in Figure 6. This amount is felt to be sufficient to perform word embedding training in sentiment analysis for pharmaceutical company because it has covered various aspects that are usually assessed by customer, such as service, satisfaction, improvement, benefits, promo, and efficacy.

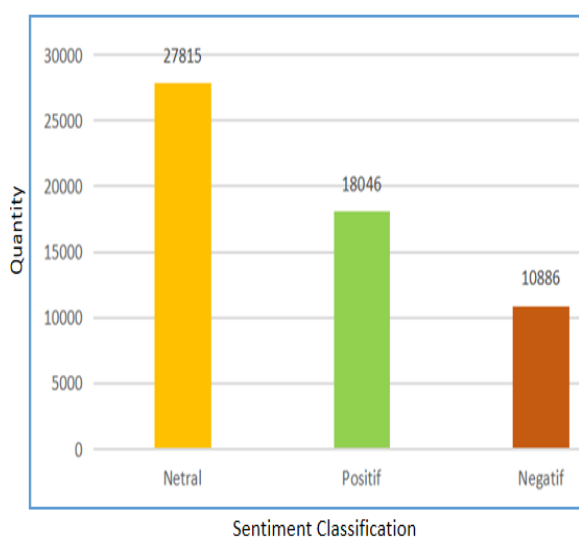


Figure.6 Datas used after sampling data

The initial experiments we use 4 models were carried out using a random under sampling technique and resulted in 100% accuracy for both the GloVe or GloVe models combined with AdaComp. In the Word2Vec model the accuracy obtained is 79% while the use of AdaComp increases the accuracy by 1% so that it is obtained 80%. The use of Random Under Sampling reduces the over fitting, but it is not optimal, so the authors add the Synthetic Minority Over-sampling Technique (SMOTE).

Random Under Sampling (RUS) works by randomly selecting samples from a large group and removing them from the data set, this will continue to be done randomly until a balanced distribution is achieved. Whereas SMOTE works by selecting the instance closest to the feature space, SMOTE first selects a minority class instance at random and finds its  $k$  nearest minority class neighbors. A synthetic example is then created by choosing one of the  $k$  nearest neighbors at random and connecting to form a line segment in the feature space. The synthetic instance is generated as a convex combination of the two selected instances  $a$  and  $b$ .

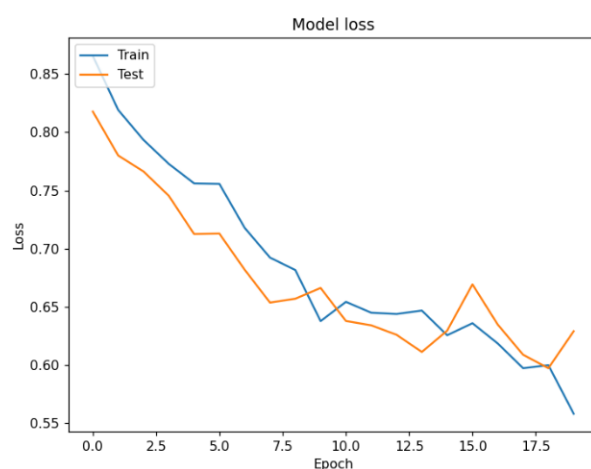
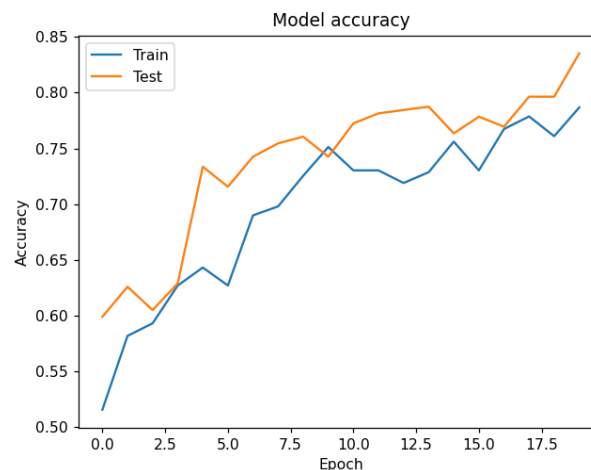


Figure.7 Accuracy model and loss model with RUS data sampling

The use of a smote has a huge impact on the resulting data. In the figure.8 we can see that the data that was previously overfitted becomes good model with the addition of a smote data sampling. As this is the best model as we get.

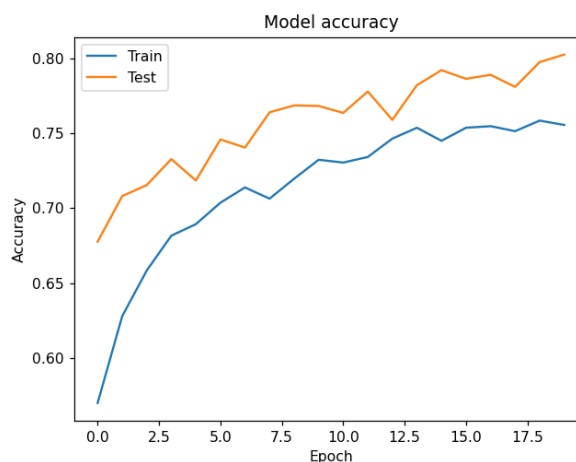


Figure.8 Model Accuracy using RUS and SMOTE data sampling

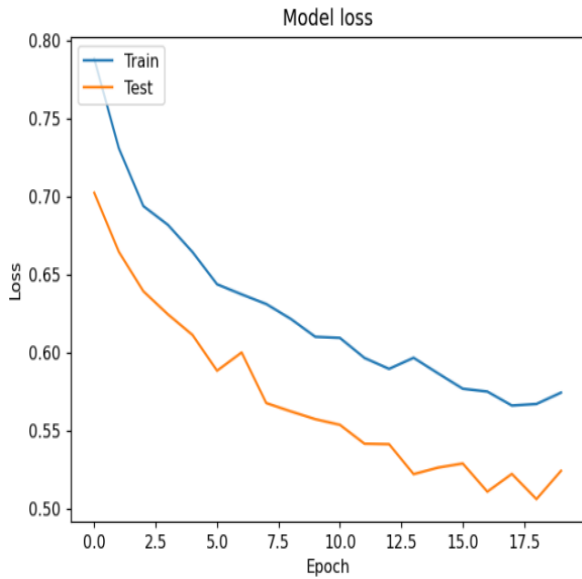


Figure.9 Model Loss using RUS and SMOTE data sampling

The accuracy obtained in both the GloVe and Word2Vec models increasing with the use of AdaComp compression. Adacomp works for each word directly learns to select its code length in an end-to-end manner by applying the Gumbel-softmax tricks. After selecting the code length, each word learns discrete codes through a neural network with a binary constraint. The accuracy results obtained on GloVe is 99%, while with the use of adacom the accuracy value increases from 1% to 100%. Then for the Word2Vec model the accuracy obtained is 80% and there is an increase of 1% with the use of adacomp compression. This summary of this result is shown in table.1

Model	RUS		RUS+SMOTE	
	Acc	Score	Acc	Score
GloVe	100	1	99	3
GloVe+AdaComp	100	1	100	1
Word2Vec	79	57	77	50
Word2Vec+AdaComp	80	56	81	49

With the use of adacomp compression the accuracy value generated on Word2Vec with RUS sampling on the evaluation shows the accuracy value increased from 77% to 81% with a True Negative value of 101, False Positive of 18, False Negative of 28 and True Positive of 92 as shown in figure 10.

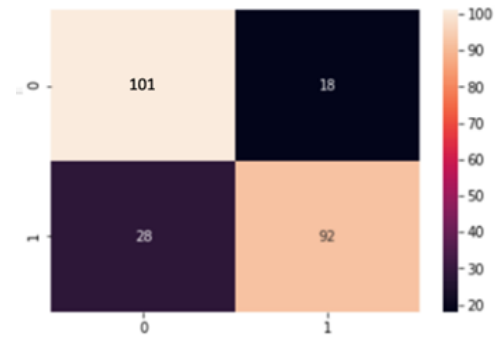


Figure.10 Evaluation for word2vec using adacomp model

```
8/8 [=====] - 1s 13ms/step
      precision  recall  f1-score  support
0      0.91      0.61      0.73      120
1      0.70      0.94      0.81      119

accuracy                0.77      239
macro avg      0.81      0.77      0.77      239
weighted avg   0.81      0.77      0.77      239
```

Figure.11 Evaluation Result for word2vec without adaptive compression (AdaComp) with RUS and SMOTE

```
8/8 [=====] - 0s 9ms/step
      precision  recall  f1-score  support
0      0.78      0.85      0.81      119
1      0.84      0.77      0.80      120

accuracy                0.81      239
macro avg      0.81      0.81      0.81      239
weighted avg   0.81      0.81      0.81      239
```

Figure.11 Evaluation Result for word2vec with adaptive compression (AdaComp) with RUS and SMOTE

From the results of the research above, the best model that can increase the highest accuracy is the word2vec model with the use of adacomp and the RUS and SMOTE sampling methods with an increase in accuracy from 77% to 81%. The use of the compression technique on adacomp has been shown to significantly improve the accuracy of the research model used, either using the RUS sampling technique or the combination of RUS and SMOTE. This is possible because the compression technique on adacomp using the Gumbel-Softmax distribution improves the workings of generic word embedding so that for each corpus used approaches the discrete data sampling process, then trained using backpropagation and choosing the length code each word adaptively.

- b. Comparison with related works in compression word embedding for sentiment analysis

To evaluate the performance of our models (AdaComp), we conduct a comparison with related works in table 2. In fact, for each language (English and Indonesian language), we conduct an evaluation on the same corpus. For the English language (Table 4), we can state that the use of adacomp give more accuracy. This claim explained by the fact that adding external resource that improves better adaptive compression. In this study we use pretrained word embedding for English version. For the Indonesian language (Table 3) we only compared our work with the work of Nawangsari et al [18]. As shown in Table 3, we notice that the use of adacomp for word2vec in Indonesian embedding is less effective to improve the accuracy.

Table 2. Comparison with existent English topic sentiment analysis

Approach	English word Embedding	Accuracy Score
Generic Word Embedding	Word2Vec	71%
Generic Word Embedding	GloVe	80.23%
Generic Word Embedding with AdaComp	Word2Vec	81%
	GloVe	100%

Table 3. Comparison with existent Indonesian topic sentiment analysis

Approach	Indonesian Word Embedding	Accuracy Score
Generic Word Embedding	Word2Vec	85.96%
Generic Word Embedding	GloVe	77%
Generic Word Embedding with AdaComp	Word2Vec	80%
	GloVe	99%

Based on this evaluation, we can conclude that using adacomp are much way better than using general word embedding without compression for both Indonesian and English languages. This can be explained by the fact that adding external knowledge enhances the quality of adaptive compression. Furthermore, we notice that prediction-based embedding methods improve adaptive compression.

## CONCLUSION

This paper focused on adacomp usage with sentiment-specific word embedding that used for pharmaceutical company sentiment analysis. Future studies should investigate the effectiveness of the proposed adaptive compression method for other word embedding model, especially for traditional word embedding sentiment analysis.

The use of compression with the AdaComp model is considered to significantly improve accuracy. This model is proven in the increase of accuracy in the research that the author did, both on imbalanced datasets and balanced datasets. In the imbalanced dataset, there is an increase in accuracy of 2%, 4% and 5% for each dataset used. However, in the best results with a balanced dataset, there is an increase in accuracy in the word2vec model with adacomp using either the RUS sampling method or a combination of RUS and SMOTE.

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## E-LEARNING IMPLEMENTATION BARRIER IN INDONESIA: A CASE STUDY

Deki Satria<sup>1\*</sup>, Neneng Rachmalia Feta<sup>2</sup>, Fitria<sup>3</sup>

<sup>123</sup>Sistem dan Teknologi Informasi

Institut Teknologi dan Bisnis Bank Rakyat Indonesia

Bri-institute.ac.id

Deki.satria@bri-institute.ac.id<sup>1\*</sup>, nrachmaliafeta@bri-institute.ac.id<sup>2</sup> fitria@bri-institute.ac.id<sup>3</sup>



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**Abstract**—Pandemic forces many educational institutions to change their learning delivery. One of the solutions is using eLearning. But, eLearning implementation faces a lot of barriers. This study tried to find the main barrier in eLearning in Indonesia. Systematic Literature Review and Descriptive statistics were used to collect and analyze our findings. The results of this study are separated into four categories: human, technology, organizational, and financial factors. Human factors include lack of interaction, hard to assimilate material, boredom, exhaustion, lack of preparation, and harder to meet the need. Technological factors include lack of technical advice, device, the internet, and power problems. The organizational factor is a lack of technical support. From the financial factors are expensive internet and device. These obstacles need to be addressed separately because each barrier has a different approach to solve.

**Keywords:** *Barriers, Covid-19, eLearning, SLR, Statistic Descriptive*

**Intisari**— Pandemi covid-19 memaksa banyak sekali institusi Pendidikan untuk mengubah pola pengajaran yang dilakukan. Salah satu cara yang paling banyak diterapkan adalah pembelajaran dalam jaringan (daring). Namun dalam pengimplementasian pembelajaran daring ini, ditemukan banyak kendala atau penghalang. Penelitian ini berusaha untuk menemukan kendala implementasi pembelajaran daring di Indonesia. Untuk menemukan penghalang tersebut digunakan systematic literature review (SLR) dan deskriptif statistik. Dari hasil penelitian yang dilakukan didapatkan empat kategori penghambat yaitu Manusia, teknologi, organisasi dan keuangan. Dari hasil penelitian tersebut didapatkan hasil hambatan manusia yaitu kurangnya interaksi, sulitnya memahami materi, kebosanan, kelelahan, kurang persiapan dan sulitnya memenuhi

keinginan siswa. Dari faktor teknologi ditemukan kendala yaitu kurangnya perangkat, sering kali adanya kendala teknis, internet dan mati lampu. Dari faktor organisasi adalah kurangnya dukungan teknis dari organisasi. Sedangkan dari faktor keuangan adalah mahalnya perangkat dan internet yang dibutuhkan. Masing-masing faktor ini harus diselesaikan secara individu dikarenakan setiap faktor memiliki penyelesaian yang unik

**Kata Kunci:** Covid-19, eLearning, Penghambat Implementasi, Statistik Deskriptif, SLR.

### INTRODUCTION

eLearning became an integral part of education processes amidst the pandemic condition. This condition occurs because the government policy limits people's opportunities to gather in one place. This policy made eLearning one of the educational institution's solutions to ensure that the education process works. eLearning itself was not a novel idea. But, the benefit of these learning methods became more noticeable in this pandemic condition (Rafique et al., 2021), and also, a lot of educational institutions became aware of eLearning benefits. Therefore eLearning is considered a strategic tool to gain competitive advantages (Coopasami et al., 2017). Informal learning educational institutions like Coursera, Udemy, and Purwadhika already used eLearning as their educational methods. They are deemed effective as learning methods because their certificate can be used as technical certification.

There were a lot of studies that tried to find how and why the eLearning implementation in higher education like university feel ineffective. Some studies attempted to find the readiness of eLearning implementation, for example, the research from Ghulam et al. (Rafique et al., 2021), Keramati et al. (Keramati et al., 2011), and Coopasami et al. (Coopasami et al., 2017). Knowing

how ready the organization is to implement eLearning is considered critical for successful eLearning Implementation. Other studies also focused on the barrier of eLearning implementation, such as the research conducted by Abu Hammad, who tried to identify the barrier children face in the implementation of eLearning in Jordan (Abuhammad, 2020). Aminu et al. also tried to identify the barrier of eLearning in Nigeria (Aminu & Rahaman, 2014). Another research conducted by Anna et al. (Fraszczyk & Piip, 2020) tried to identify barriers in railway sectors eLearning.

Research or studies on barriers can be generalized because many areas have different barriers. For example, Aminu et al. (Aminu & Rahaman, 2014) the research found that the main barriers in eLearning in Nigeria are infrastructure and financial. But, if we see the results of Anna et al.'s research on railways eLearning in Australia (Fraszczyk & Piip, 2020), They found that infrastructure is not one of the barriers they found. The main finding of Anna et al. is more focused on the people problems like skill and interaction.

This research tried to find what the Indonesian academic community member deemed the barrier in Indonesia's eLearning implementation. The result of this research will be presented in the descriptive statistic. The institution and government can use the results of this study to make a more effective strategy or eLearning system.

**MATERIALS AND METHODS**

This research is descriptive statistic research. We start the studies by conducting a Systematic Literature Review (SLR). The result (SLR) has been published in our previous publication (Satria, 2022). We used the

Kitchenham SLR framework to gather barriers from several research databases. The Kitchenham protocols can be seen in Figure 2 SLR Protocols. After gathering the barrier factors of eLearning, we create a questionnaire to collect the data from respondents. Before we spread the questionnaire, we conduct a simple readability and validity test to see the wording in the questionnaire. The questionnaire that we made was shared with several people to check if they could understand the wording of the questionnaire. The questionnaire spread into several academic communities. We do not limit the respondents only from higher education but also from another level of education as long as it is formal. After the data was gathered, we cleaned it and processed it into descriptive charts and diagrams. Descriptive statistics is methods to summarize and provide the statistical information in diagram, therefore It could be easier to take conclusion from (Yao et al., 2022). Figure 1 Research Methodology shows the methodology of this research.

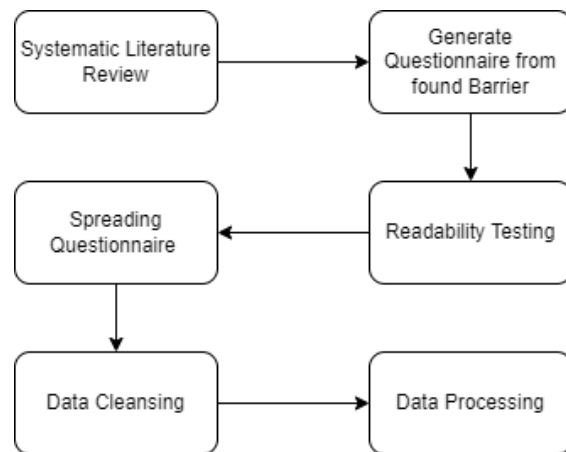


Figure 1 Research Methodology

**Tabel 1 eLearning Implementation Barriers**

Code	Barrier of eLearning	Source	Code	Barrier of eLearning	Source
<b>Human</b>			<b>Technology</b>		
H1	Lack of Interaction	(Ismaili, 2021), (Abuhammad, 2020)	T1	Accesibility	(Ismaili, 2021; Montazer & Kareem Al-Rikabi, 2021)
H2	Harder to Assimilate Material	(Ismaili, 2021)	T2	Dificulty in Online Exam	(Ismaili, 2021)
H3	Resistancy	(Ismaili, 2021), (Idris & Osman, 2016), (Montazer & Kareem Al-Rikabi, 2021), (Naveed, Qureshi, Alsayed, Muhammad, et al., 2018)	T3	Inaappropriate Infrastructure	(Naveed, Qureshi, Alsayed, Ahmad, et al., 2018; Naveed, Qureshi, Alsayed, Muhammad, et al., 2018; Roman & Plopeanu, 2021), (Aminu & Rahaman, 2014)
H4	Lack of ICT Skill	(Naveed, Qureshi, Alsayed, Ahmad, et al., 2018; Naveed, Qureshi, Alsayed, Muhammad, et al., 2018)	T4	Technical Problems	(Abuhammad, 2020; Idris & Osman, 2016; Stefancik & Stradiotova, 2021)

		2018), (Abuhammad, 2020), (Fraszczyk & Piip, 2020)			
H5	Lack of Digital Literacy	(Fraszczyk & Piip, 2020; Naveed, Qureshi, Alsayed, Ahmad, et al., 2018)	T5	Lack of Technological device like computer	(Aminu & Rahaman, 2014; Montazer & Kareem Al-Rikabi, 2021)
H6	Lack of English Proficiency	(Naveed, Qureshi, Alsayed, Ahmad, et al., 2018), (Idris & Osman, 2016), (Montazer & Kareem Al-Rikabi, 2021; Naveed, Qureshi, Alsayed, Muhammad, et al., 2018)	T6	Internet problems	(Montazer & Kareem Al-Rikabi, 2021), (Aminu & Rahaman, 2014; Roman & Plopeanu, 2021; Stefancik & Stradiotova, 2021), (Abuhammad, 2020)
H7	Weak Motivation	(Montazer & Kareem Al-Rikabi, 2021; Naveed, Qureshi, Alsayed, Ahmad, et al., 2018; Naveed, Qureshi, Alsayed, Muhammad, et al., 2018), (Stefancik & Stradiotova, 2021)	T7	Power Problems	(Aminu & Rahaman, 2014; Montazer & Kareem Al-Rikabi, 2021)
H8	Lack of Pedagogical Skill	(Fraszczyk & Piip, 2020; Naveed, Qureshi, Alsayed, Muhammad, et al., 2018)(Abuhammad, 2020)(Roman & Plopeanu, 2021)			
H9	Education Method	(Abuhammad, 2020; Montazer & Kareem Al-Rikabi, 2021)			
H10	Lack of Compensation and Time	(Fraszczyk & Piip, 2020; Montazer & Kareem Al-Rikabi, 2021; Naveed, Qureshi, Alsayed, Muhammad, et al., 2018)			
H11	Distrust	(Montazer & Kareem Al-Rikabi, 2021; Stefancik & Stradiotova, 2021)			
H12	Boredom	(Montazer & Kareem Al-Rikabi, 2021)			
H13	Frustration	(Montazer & Kareem Al-Rikabi, 2021; Roman & Plopeanu, 2021)			
H14	Exhaustion	(Stefancik & Stradiotova, 2021)			
H15	lack of student preparation	(Abuhammad, 2020)			
H16	Inability to meet students' need	(Abuhammad, 2020)			
	<b>Organizational</b>			<b>Financial</b>	
O1	Lack of Technical Support	(Naveed, Qureshi, Alsayed, Ahmad, et al., 2018)(Naveed, Qureshi, Alsayed, Muhammad, et al., 2018)	F1	Financial Condition	(Aminu & Rahaman, 2014; Montazer & Kareem Al-Rikabi, 2021)
O2	Lack of Financial Support	(Naveed, Qureshi, Alsayed, Ahmad, et al., 2018)	F2	Lack of Investment	(Abuhammad, 2020)
O3	Lack of Inadequate Policy	(Naveed, Qureshi, Alsayed, Ahmad, et al., 2018)	F3	Expensive device	(Abuhammad, 2020; Aminu & Rahaman, 2014)
O4	Lack of Training in eLearning	(Naveed, Qureshi, Alsayed, Ahmad, et	F4	Expensive internet	(Abuhammad, 2020)

		al., 2018), (Idris & Osman, 2016), (Aminu & Rahaman, 2014; Montazer & Kareem Al-Rikabi, 2021)
05	Lack of Instructional Design	(Naveed, Qureshi, Alsayed, Ahmad, et al., 2018)
06	Privacy and Security	(Idris & Osman, 2016)
07	Shortage of Technical Staff	(Abuhammad, 2020)
08	Cultural	(Montazer & Kareem Al-Rikabi, 2021)
09	lack government support	(Montazer & Kareem Al-Rikabi, 2021)
010	Lack of quantity and quality Content	(Montazer & Kareem Al-Rikabi, 2021)

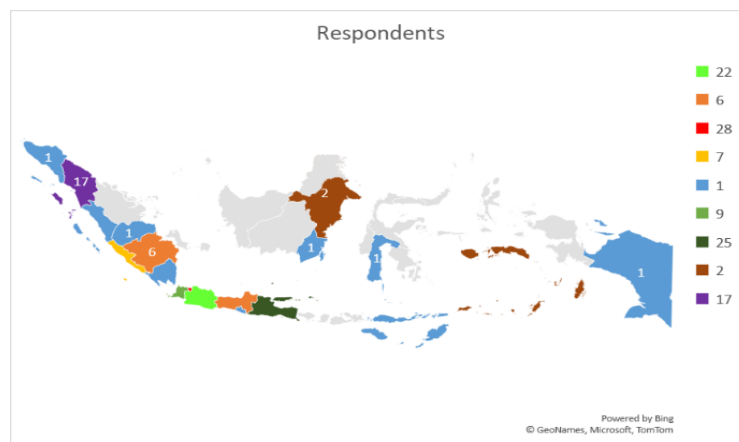


Figure 2. Respondent Sources

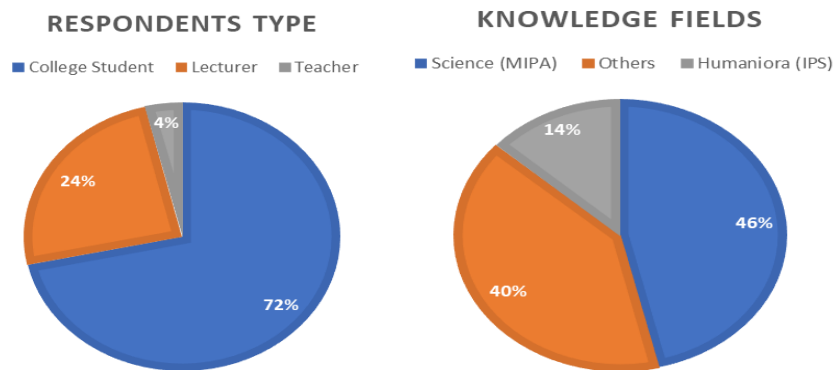


Figure 3. Respondents Type and Knowledge Fields

### RESULT AND DISCUSSION

After collecting and clustering the barrier we found, we created the questionnaire and shared it with some colleagues to check if our questionnaire was easy enough to understand and won't have any possibilities to confuse our respondents. The questionnaire can be accessed through this link <https://bit.ly/eLearningInd>. The

questionnaire used a Likert scale from 1 to 5, where 1 strongly disagrees and 5 strongly agrees.

We gathered 136 data from all around Indonesia. After some data cleansing, we gathered 134 data. The demographic data can be seen in Figures 2 through 3. In Figure 2, we can see that we could gather some representatives from western and eastern Indonesia; even though the number doesn't look balanced, it is pretty representative. In

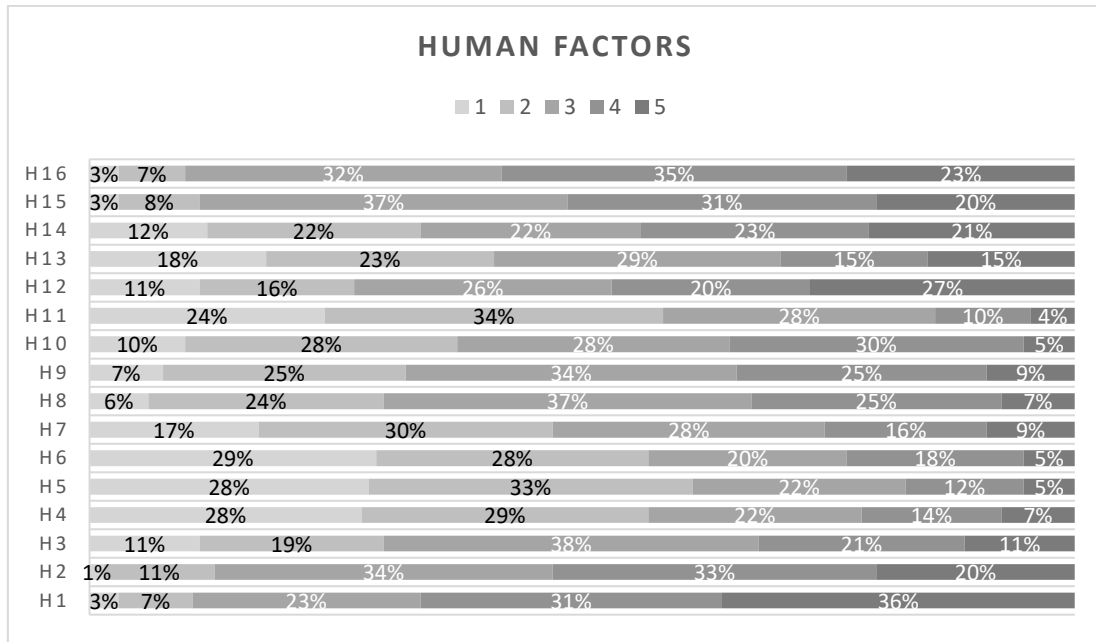


Figure 4 Human Factors

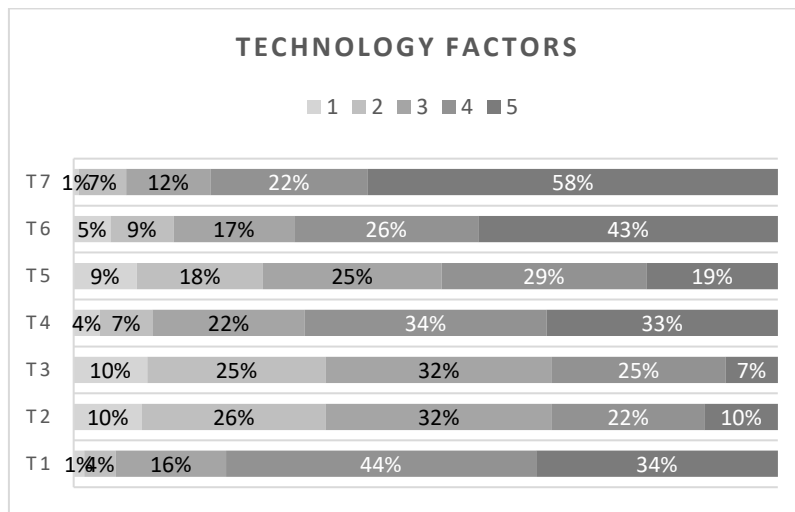


Figure 5 Technology Factors

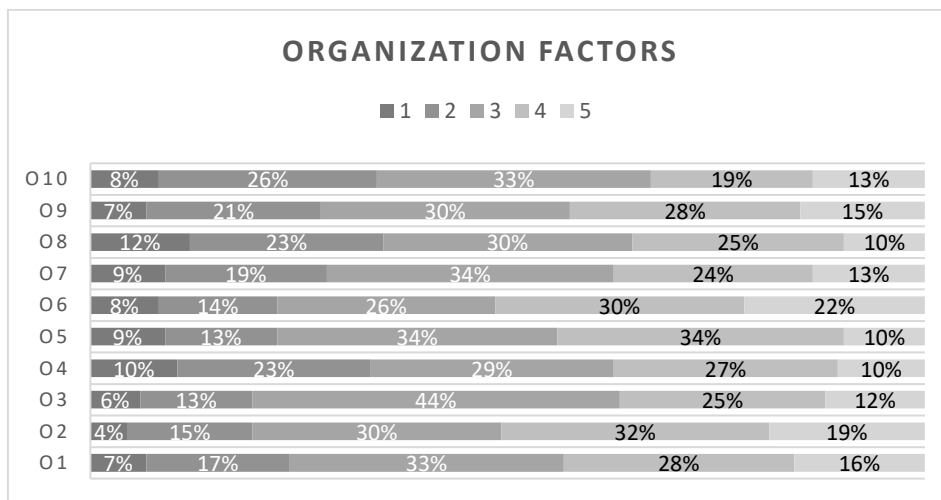


Figure 6 Financial Factors

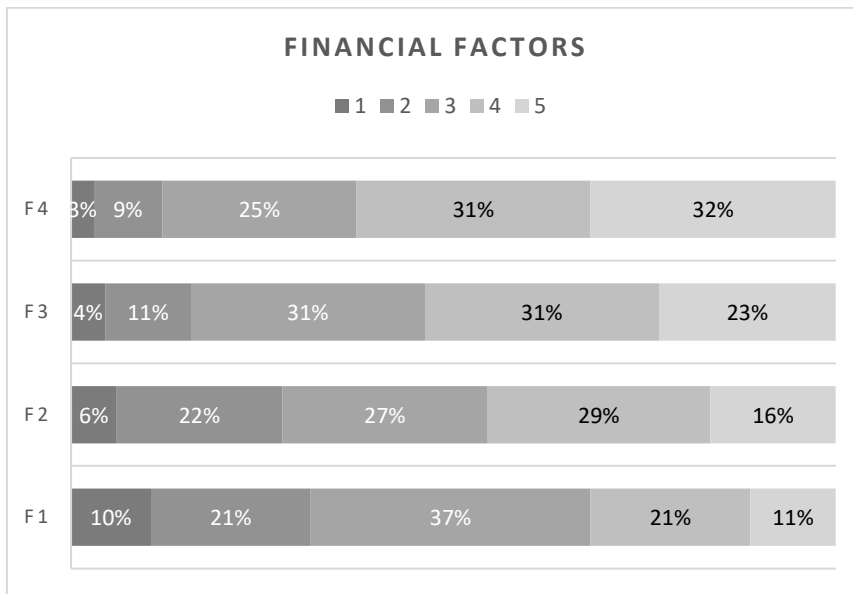


Figure 7 Technological Factors

figure 3, we can see that the respondent's types are Mahasiswa (College Students), Guru (Teacher), and Dosen (Lecturer). The main respondents in this survey are college students and lecturers because almost all universities are conducting eLearning amidst this pandemic. From Figure 4, we can see that the respondent's fields almost event between Science and Humaniora. This research will consider the scale 3 as abstain or neutral. Therefore we will consider only the results on a scale of 1 and 3 for disagree and 4 and 5 for agree. In this research, we do not gather the age, and gender data, because it doesn't relate to the outcome we expected. In this research, we only want to know the perspectives of eLearning from both students and teachers in the implementation of eLearning they currently use.

From Figure 4 Human Factors, H1 became one of the most agreed barriers, with 35% Strongly Agreeing and 31.6% agreeing. The eLearning methods usually used are conference meetings or self-studied, which diminishes the interaction in learning even though interaction is one of the key components of successful studies (Okita, 2012). The interaction, in this case not limited to interaction between teacher and students but also between the students. This research also related to the next barrier, which is H2. In their research, Okita (Okita, 2012) mentioned that interaction help students in processing and understanding the materials.

On the other side, English is not a learning barrier for Indonesian academic society, even though Indonesia ranked 80th among 112th countries indexed based on the EF survey. This result directly relates to other barriers, which are

the IT literacy barrier. Based on Kusumastuti et al., (Kusumastuti & Nuryani, 2020) Indonesia ranked third for digital literacy in ASEAN, below Singapore and Thailand. Our finding is a bit different from research (Naveed, Qureshi, Alsayed, Ahmad, et al., 2018), (Idris & Osman, 2016), (Montazer & Kareem Al-Rikabi, 2021; Naveed, Qureshi, Alsayed, Muhammad, et al., 2018), which mentioned that one of the barriers in the eLearning their case studies faced is the English proficiency of the eLearning user.

The next barrier we found considered as the eLearning barrier is H12 and H14. This finding is supported by the other research from Montazer et al. (Montazer & Kareem Al-Rikabi, 2021) and Stefancik et al. (Stefancik & Stradiotova, 2021). Staring at a PC monitor all day long can make the learner and the lecturer or teacher become exhausted.

H15 also became a barrier to learning in this research finding. Of 43 people filled agree and 27 filled strongly agree, 46 data came from students and college students, and only 24 data from teachers.

The next barrier is hard to meet students' H16. We gathered that 56 students agree with this barrier, which means they don't feel the learning material or the learning season meets their expectations. To tackle this barrier, the lecturer and the institution need to conduct some research to see their expectations and how to achieve them.

The next barrier is technology as can be seen in Figure 5 Technology Factors. A lot of research found that technology is one of the main



reasons eLearning cant run as well as expected, especially in this sudden pandemic condition.

We found that T4, T5, T6, and T7 became the main barriers from the technological aspect. This barrier was also found by (Abuhammad, 2020; Montazer & Kareem Al-Rikabi, 2021), (Aminu & Rahaman, 2014; Roman & Plopeanu, 2021; Stefancik & Stradiotova, 2021) in their respective case studies, which were mainly conducted in developing countries such as Iraq, Slovakia, Nigeria, and Romania. In Indonesia itself, this problem became more prevalent in the pandemic condition.

Many students and teachers in developing areas can't conduct learning activities because of the lack of supporting infrastructure. This finding is also supported by the result of a study conducted by CIPS in 2020 (Azzahra, 2020). Their finding found that making reliable internet infrastructure is hard in Indonesia. The hard topography in Indonesia made this problem occur, especially in remote areas.

The next factor is organizational factors as can be seen in Figure 6 Organizational Factors. O1, especially from the perspective of new users, became a barrier. This problem was also found by (Naveed, Qureshi, Alsayed, Ahmad, et al., 2018; Naveed, Qureshi, Alsayed, Muhammad, et al., 2018). They found that good technical support can help the user troubleshoot their difficulties.

The last category of barrier is financial factors as can be seen in Figure 7 Financial Factors. The factor considered barriers by our respondents are expensive internet (F4) with 30.9% agree and 31.6 % strongly agree, expensive devices (F3) with 30.9% agree and 22.8% strongly agree, and lack of institutional investment with 28.7% agree and 16.2% strongly agree.

This result is expected in this pandemic condition. As we know, the Indonesian economic growth in pandemics decreased in 2020 (BPS, 2021). This condition affected a lot of sectors in Indonesia. On the other side, the study from CIPS [17] also found that many students, especially the low income and students who live in the

countryside, are greatly affected by this condition. Therefore another way of study is needed to tackle these problems.

CIPS (Azzahra, 2020), in their studies, gave some recommendations to tackle these problems, especially for technological and financial factors. One of the solutions is using national television to provide the materials needed, especially for elementary through senior high school. This recommendation was already implemented prior to this research.

After finding the barriers to implementation, we could determine the required requirements to implement eLearning better in the future. For this requirement, we focused on the system functionality. We divide the functionality based on the barriers.

From the human factors, we know that most of the implemented eLearning at this time was boring, lacked to no interaction between the students and the lecturer or the teacher, exhaustion, and lack of preparation. eLearning could have something fun like a game or gamification function in the eLearning. The gamification functionality is already used by many learning platforms such as Duolingo, as shown in Figure 8.

As the eLearning implementer or developer, the educational institution could adopt this kind of functionality in their LMS. The learner won't feel burdened by the materials and not be as easily bored.

Another functionality that can be added to the LMS is the community function. Duolingo implemented this functionality in order to enhance the interaction between the user on their platform. eLearning, especially Moodle-based, actually also had this functionality.

Having the community features in the LMS could enhance the learning experience and make the learning process more fun because the learner feels as if they interact with their friend. In this scenario, the teacher could lead the discussion and give additional information to the discussion.

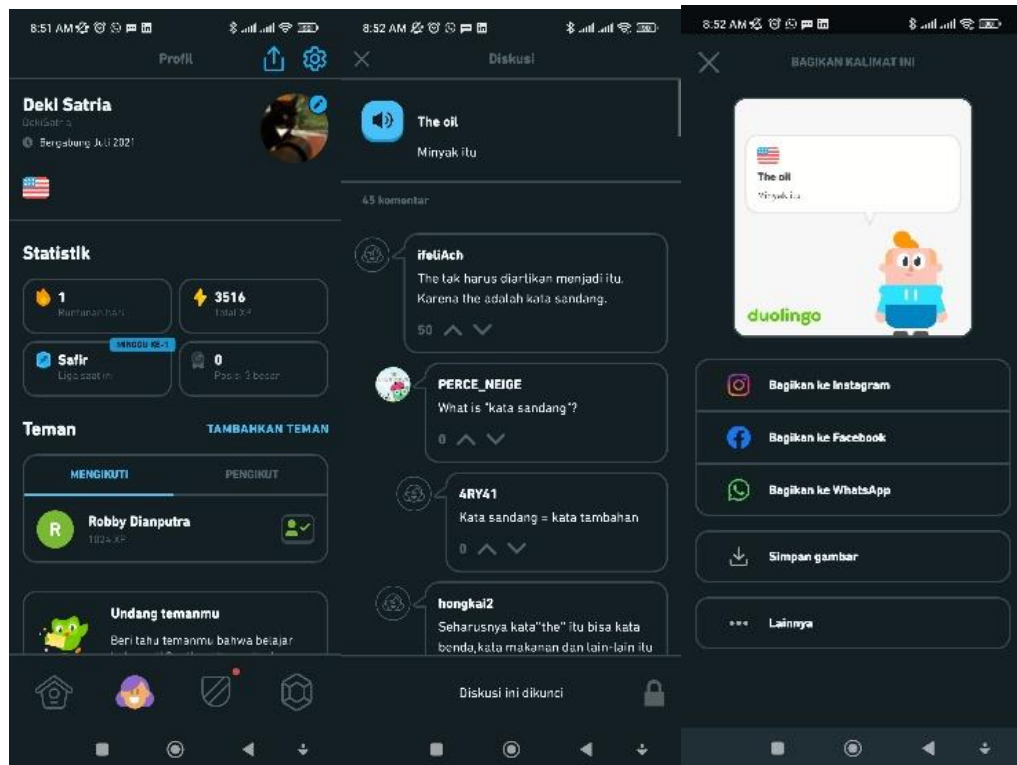


Figure 8 Duolingo Gamification and Community Feature

### CONCLUSION

eLearning Implementation in the organization has several barriers from the three criteria: Human, Technologies, Organization, and Financial. The Human Factor barriers found in this research are Lack of Interaction in the Learning Process, Harder Material Assimilation, Boredom, Exhaustion, Lack of Preparation, and Inability to meet Student's Needs. From the Technological Perspective, the barriers found are Technical Problems, Lacking technical devices, Internet Problems, and Power Problems. From the Organization's Perspective, lack of Technical Support became the main barrier; from Financial Perspective, Expenses for the device on the internet became the main problem.

To tackle the barriers, implementing the Gamification feature can reduce boredom and increase the interaction between the students and students and student and the teacher/lecturer. Using national television as the learning method could also reduce eLearning expenses. Another method that can be implemented to tackle these problems is implementing a community to help other learners, which can also act as technical troubleshooters for the problems met by the learner.

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## PROTOTYPE OF DIGITAL LIBRARY APPLICATION USING MICROFRAMEWORK FLASK

Ridha Sefina Samosir<sup>1\*)</sup>; Ester Lumba<sup>2</sup>; Poltak Pancarian Situmorang<sup>3</sup>

Program Studi Sistem Informasi<sup>1,3</sup>  
Institut Teknologi dan Bisnis Kalbis  
ridha.samosir@kalbis.ac.id<sup>1\*)</sup>  
www.kalbis.ac.id<sup>3</sup>

Teknik Informatika<sup>2</sup>  
Universitas Bunda Mulia  
www.ubm.ac.id  
l0178@lecturer.ubm.ac.id<sup>2</sup>



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**Abstract**— Covid-19 encourages the use of Digital Library sources. especially for students who are completing college assignments, wtudents who are preparing their final project, lecturer in compling teaching material, including researchers. On the other hand, technology has developed rapidly. Technological developments have changed the pattern of human life and changed the business models of various organizations in order to survive in this digital era. However, there are still many organizations have not optimized the use of technology. One example is a university that does not yet have a Digital Library. This prompted the research team to conduct research on how to build a Digital Library. This study uses the Extreme programming (XP) software development method. This study aims to design a Digital Library prototype using a Microframework Flask. This research is expected to be a reference or model in developing digital libraries.

**Kata Kunci:** digital, flask, Digital Library, prototype, XP

**Intisari**— Pandemi Covid-19 mendorong pemanfaatan sumber-sumber pustaka secara digital. Perpustakaan digital sangat di butuhkan dalam situasi pandemi oleh mahasiswa yang sedang membuat tugas-tugas kuliah, mahasiswa yang sedang menyusun tugas akhir. dosen dalam menyusun bahan ajar dan para peneliti. Di sisi lain teknologi sudah berkembang demikian pesatnya. Perkembangan teknologi telah mengubah pola kehidupan manusia dan mengubah model bisnis berbagai organisasi agar tetap survive di era digital ini. Namun secara khusus institusi pendidikan

belum memaksimalkan pemanfaatan teknologi. Salah satu contoh adalah banyak institusi pendidikan yang tidak memiliki perpustakaan digital. Hal ini mendorong tim peneliti melakukan penelitian bagaimana membangun perpustakaan digital. Penelitian ini menggunakan metode pengembangan perangkat lunak Extreme programming (XP). Penelitian ini bertujuan untuk merancang prototipe Digital Library menggunakan Microframework Flask. Melalui penelitian ini diharapkan dapat menjadi acuan atau model dalam mengembangkan perpustakaan digital (Digital Library) bagi institusi-institusi pendidikan.

**Kata Kunci:** digital, microframework flask, library, prototype, XP.

### INTRODUCTION

The COVID-19 pandemic has changed the social life of humans and organizations in various sectors. Likewise, higher education also changes the way of learning from face-to-face in class to virtual (online) (Endang Kartini, Lalu Mimbar, 2021). Before the COVID-19 pandemic emerged, some universities had implemented online learning specifically for specific subjects. However, currently, all courses must be delivered online, including practicum courses which should be in the laboratory. Including reference sources in various libraries that have been available in print versions, they must keep up with changes. The COVID-19 pandemic is precisely the right momentum to improve the education ecosystem, including the availability of digital library resources on campuses (Fitriyani., Mukhlis, 2021).

Higher education students need to cite some references provided by the library in their university to finish their lecturer assignments or final assignments. But during this pandemic, almost all campuses, learning activity including libraries, do not operate offline. The impact of this condition shows that the quality of student assignments is not good because students get answers only by relying on the google search engine. In addition, the students' insight from the tasks was lacking in detail. It will be different if students get answers directly by reading suitable library sources. Through appropriate library sources, students gain better insight. In addition, the quality of assignments produced by students is also better. With the increase in cases of positive COVID patients, many universities still decide to carry out operations activities on campus online. This condition also provides an opportunity for libraries to improve their services as learning centers and sources of information by of digitalization. In the end, more and more people besides the academic community can access these digital library resources.

Based on the problems described above, the research team proposes research to design a prototype (Susanto & Meiryani, 2019) digital library using Microframework Flask. Flask is the Digital Library development framework because it is pretty light and has flexibility in terms of using components for web applications provided by third parties. Flask has no dependencies for web application project settings. In contrast to other web development frameworks in general, which already offer all components in one framework, even though not all of these components are used. Flask has high scalability because it's perfect for simple and complex web applications. So the extensions used can be adapted to the needs of the application.

The results of this study are expected to be the basis for developing a Digital Library for educational institutions and society in general. (Aruna, 2015). *Digital Library is an application that gives users access as members to borrow and read content available in digital form via computers and smartphones.* (Suharso et al., 2020). Digital Library is an application that gives users access as members to borrow and read content available in digital form via computers and smartphones. Every member, anytime and anywhere, can access library resources in the Digital Library through computer and mobile devices.

In application development, this study proposes the extreme programming (XP) method (Ayu Megagawaty et al., 2021). The XP method is suitable for small and medium development teams, considering the team only has three people. In

addition, the software developed is also not too complex. In addition, the need for digital libraries during the COVID-19 pandemic is quite urgent, so a fast development process is needed. Data collection is done through observation and interviews with the library to explore business processes, bibliography data, bibliography classification, digital documents from library sources, and others.

Several studies on Digital Library development have been carried out. A researcher tried to research the quantity of access to the Digital Library from 2002 to 2016 (K. Ahmad et al., 2018). The results of the study show that there are more than 4,236 documents on the ISI Web of Science, the productivity of the number of research publications through the Digital Library, an increase in the number of citations, the United States as a leader, and others. Other research says that smart libraries are a necessity in the 21st century (Shah & Bano, 2020). Smart libraries provide many services by leveraging the IOT architecture. One of the modeling methods in the development of the Digital Library is using the DeLone and McLean method (Alzahrani et al., 2019).

The findings of this study are the quality of a good system affects the level of satisfaction and intention of users or accessing materials in the Digital Library. Digital Library development can be done by utilizing an open-source platform. The principle used in the development of the Digital Library in this research is the user's need to access content easily and free of charge (Arora, 2018).

## RESEARCH AND METHODOLOGY

The method of collecting data in this research is through interviews and observations of the library unit to explore all the data and business processes that occur there, including digital documents from library sources, books, journals, and other library sources. This study's data source is a library at a private university in Jakarta. In addition, researchers also do literature review through books and journals related to the research for exploring the current digital library application update. Development of Digital Library Prototyping using the Flask Microframework approach and follows the rules of software development named Extreme programming (XP) (Vrbančič et al., 2018). Figure 1 is life cycle of XP Programming method

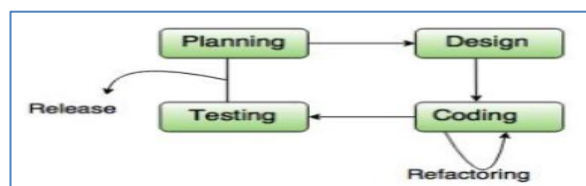


Figure 1. Software Development Life Cycle of XP

XP is a fast, efficient, low-risk, flexible, predictable, scientific software development method (I. Ahmad et al., 2020). This model uses an Object-Oriented approach. In Extreme programming, trim and medium-sized teams can be formed. The goal is to deal with unclear requirements as well as the occurrence of swift changes in requirements. The stages in software development using the Extreme programming method consist of planning, design, coding, and testing.

To do requirements analysis and system design process, Unified Modeling Language (UML) is used for documenting (documentation artifacts) and modeling the system (Sari, 2018). UML diagram can help to present a problem easier. Also facilitate for needs understanding quickly.

Overall, the framework of this research begins with the literature study to explore the development of digital libraries and then continues with the formulation of research problems. Then proceed with observations and interviews to collect all the data needed.

After all the data is collected then, start building the system. However, system development is just until developing a prototype of the system. The prototype system that has been completed is then tested using the black box method. Finally, the study ends with concluding.

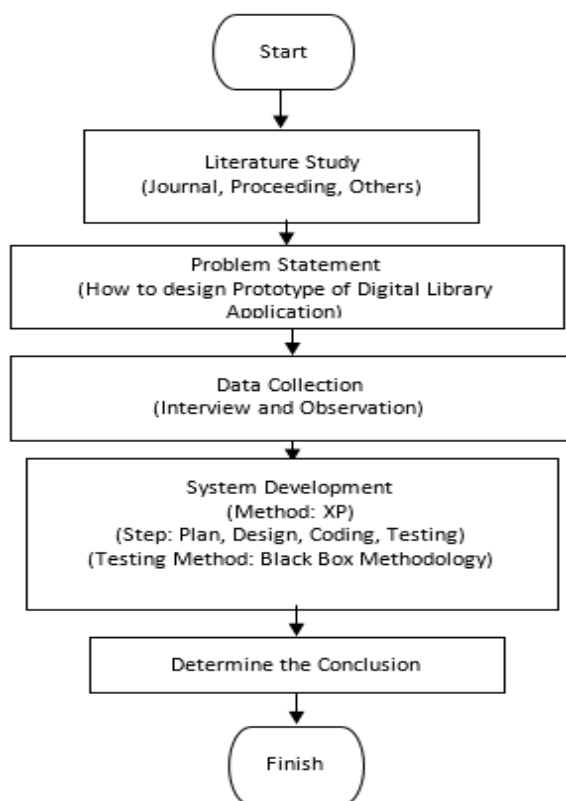


Figure 2. Research Framework

## RESULT AND DISCUSSION

This section explains all the results obtained from all stages, especially the system prototype development stage. Following the extreme programming method, the development stage includes planning, design, coding, and testing.

### Plan

In this section, the research team analyzes why this digital system or application needs to be developed. The things that are done are by making System Requests, Business Needs, Business Values, non-functional requirements, functional requirements, making use case diagrams and use case descriptions:

- A. *System Request*: The COVID-19 pandemic situation requires lectures to be conducted online. This causes access to conventional libraries to be constrained. Therefore, the library manager wants to create a digital library system so that it can be accessed online.
- B. *Business Needs*: This application was built for the literacy needs of students and lecturers. Literacy is needed to prepare teaching materials for research or final assignments and college assignments.
- C. *Business Value*: This application will reduce the cost of rent, librarian and administrative costs.
- D. *Non Functional Requirements Analysis*: This web-based Digital Library application has non-functional requirements, which are divided into four parts, namely:
  1. *Operational Needs*
    - The application needs WSGI and Library Flask, *database* management system (MariaDB).
    - Provider for Hosting. This apps can be accessed through internet connection.
  2. *Performance Needs*
    - Response time not more than 20 seconds while user access main menu and all features.
  3. *Security Needs*
    - Just administrator can do activation or reactivate the member.
    - Just member can access the digital library system.
  4. *Politics and Culture Needs*

- There are no special needs related to politic and.
- E. Fuctional reuirement of this system consist of three part such as data management (references), membership, and academic data management:

### Design

At this stage, the team builds the Digital Library application architecture and makes modelling by designing use case diagrams and class diagrams. The first step is building the Digital Library application architecture, shown in Figure 3 below. In Figure 3, both admin and member users access (make a request) the Web Server Gateway Interface (WGSII), and then the WGSII server responds according to the request from the client. Through the Application Programming Interface (API), the WGSII server communicates with the Academic System when performing certain data operations. In this case, the client is a system user, both admin and members (students, lecturers). The team's next step is to design an activity diagram based on the use case diagram and use case description of this Digital Library application. After creating a use case diagram, the next step is to create a class diagram of this digital library application. The class diagram is built based on functional requirements on use case diagrams and activity diagrams.

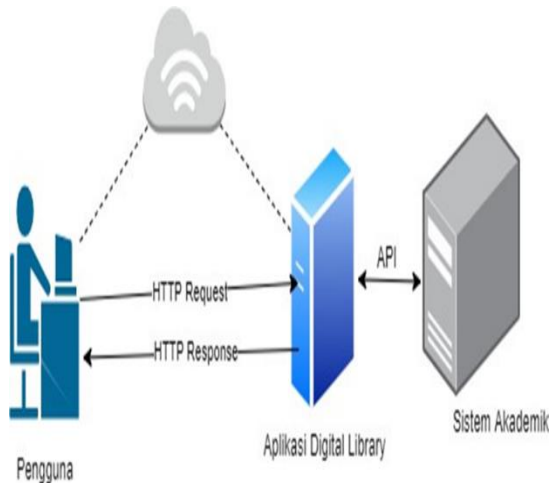


Figure 3. Design of Digital Library Architecture

Based on the class diagram, 8 (eight) classes will simultaneously be modelled on the database, including lecturers, students, departments, members, authors, books, and publishers. However, the class of students, lecturers and the modelling department is carried out in the academic system. All these classes will define the

modules to be developed through coding. The information in the class shows the attributes (variables) and methods (processes) that are applied to the class. Figures 6, 7, and 8 represent use cases, classes, and activity diagrams.

### Coding

Following the XP method, coding is the third stage after the design stage. Coding means translating the design results into code with a programming language. The team coded the program using Python and the Jinja2 template with Microframework Flask at this stage. The first thing to do is to create a project structure with a directory structure, as shown in Figure 4 below:

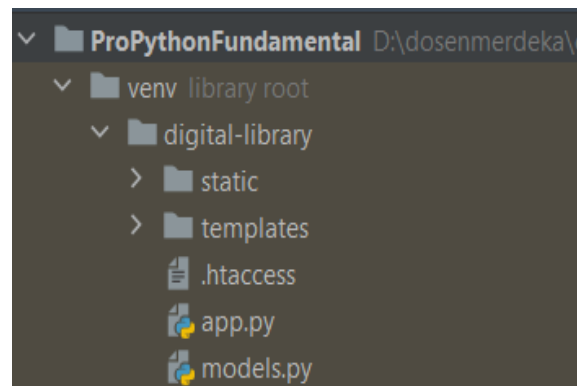
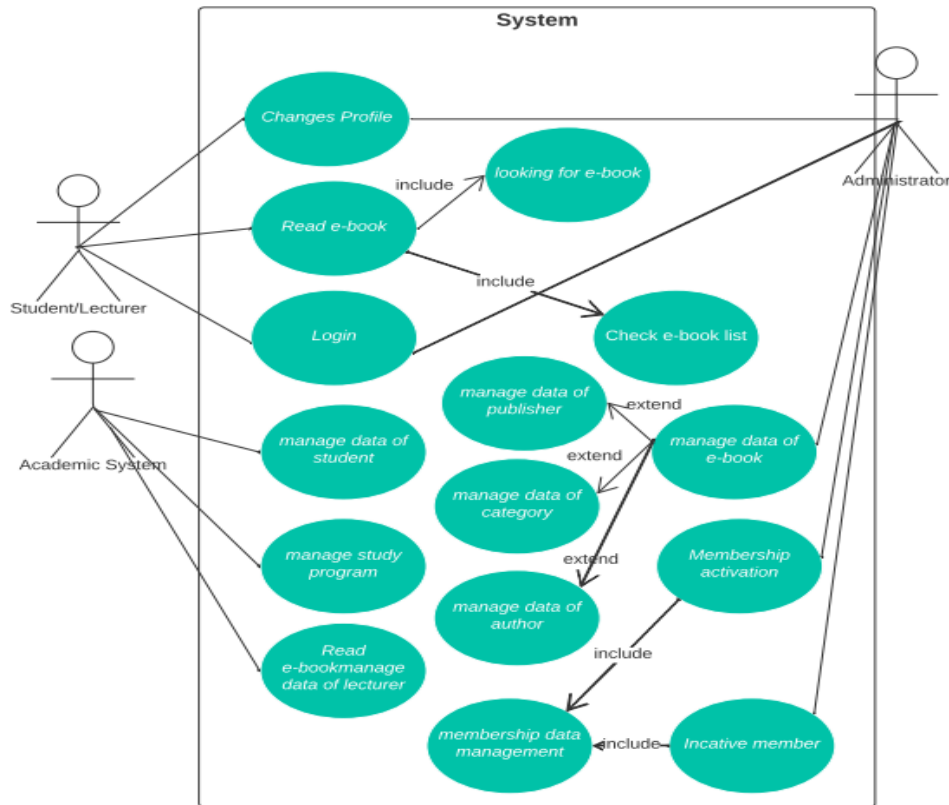


Figure 4. Project Structure

The Digital Library Application Project is created in a virtual environment with the name venv. Digital Library is the name of the project's folder in which there is a static folder that is useful as a place to store all project assets. The templates folder stores file written using the jinja syntax and HTML. The models.py file is written using the Python syntax used for user modelling. Inside the model, the User class is declared, which is used to instantiate user objects in the application. The whole program code snippet from models.py is shown in figure 5.

```
67 # fungsi sebagai route ketika aplikasi pertama kali dipanggil
68 # aplikasi akan diarahkan ke halaman login
69 @app.route('/')
70 def index():
71     return render_template('login.html')
72
```

Figure 5. Program Script



Gambar 6. Usecase Diagram

**Result**

The results of this study are a prototype of a digital library application written in the Jinja file format (Armash Aslam et al., 2015). According to the explanation of the advantages of Flask, in writing this prototyping program, many libraries are used and are not tied to the framework. Therefore, developers can take existing components without following the usage rules set by the framework. In addition, when the prototype is executed, it does not require too heavy computation because Flask is relatively light in programming.

Users of this application consist of admins as managers of digital library applications and members consisting of lecturers and students. This application is still running on the local computer. To access it, use the URL <http://localhost:5000> (<http://127.0.0.1:5000>) in the browser's address bar. The Sign-In page will be displayed when accessing the URL, as shown in Figure 7. All users will use this page to enter the digital library application. When logging into the system, you will

enter the admin page or member page according to the role of each user.

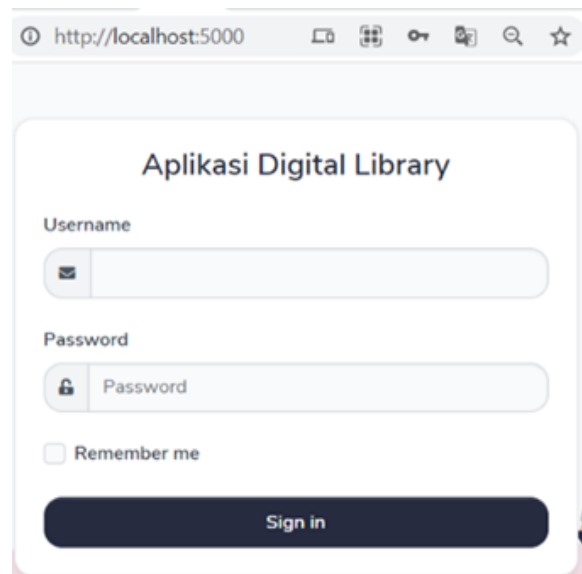


Figure 7. Sign In Menu



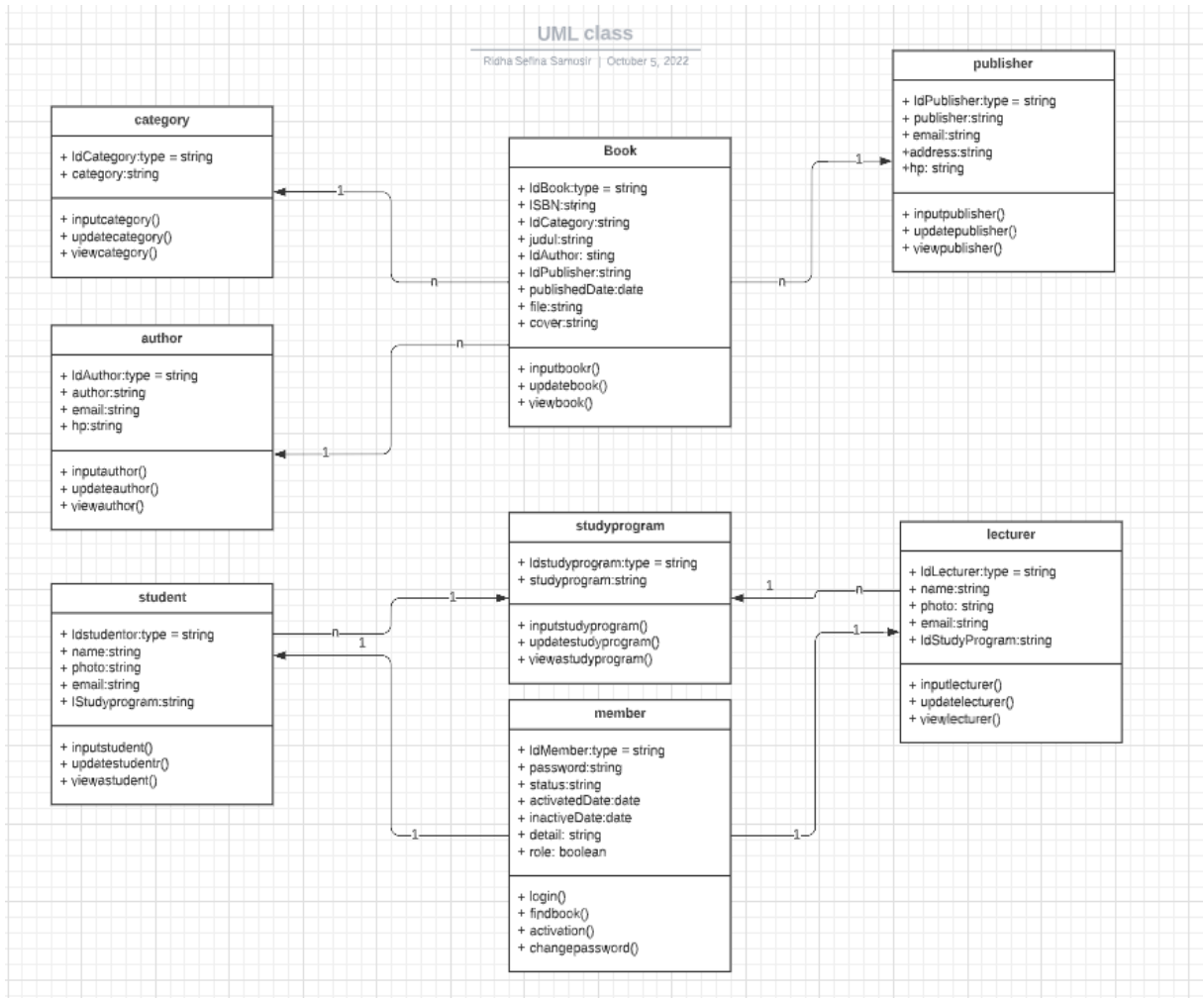


Figure 8. Class Diagram

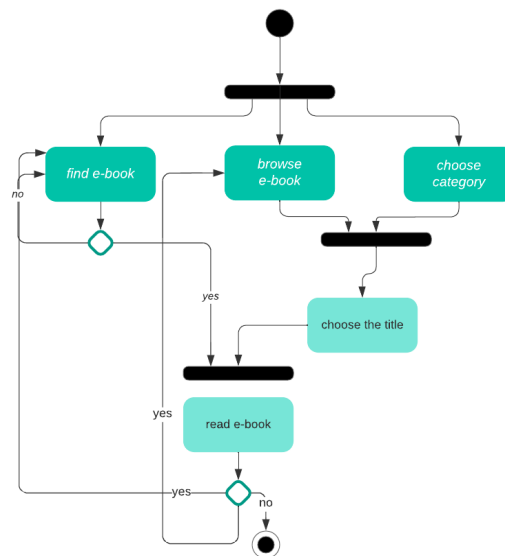


Figure 9. Activity Diagram Read E-Book Function

Another prototype is for admin and user menus. Users use the menu with admin roles to

manage ebook lists, members, ebook catalogues, ebook categories, authors and publishers. The

admin has complete control over the application, which is to add data, change and delete data on each entity in this application. A menu also shows the ebook list management page owned by the Digital Library application. Admin has full rights on this page, such as being able to add ebook data, change or modify ebook data and can delete ebook data. On the member page, there is only an ebook catalogue menu. All users have the right only to view the list of ebooks through the catalogue menu and can read the ebooks listed in the catalogue. Figure 10 is a display of the ebook catalogue that users can access.

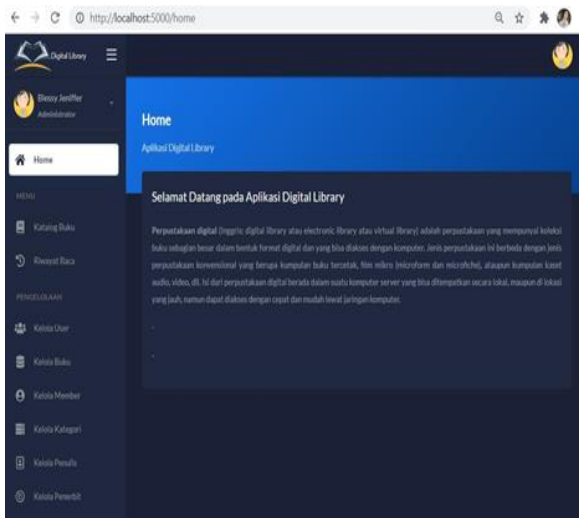


Figure 10. E-Book Catalogue Menu

**Testing**

At this stage, the researcher conducts prototype testing to determine whether its functions are as expected. The testing method used is the black box method (Cabana et al., 2018) with alpha testing. Table 1 is the result of testing with alpha testing of the proposed prototype. Functions tested based on features/functions in use case diagrams (Hamza & Hammad, 2019):

No	Function	Detail	Result
1	Login Function	Access (entry) Digital Library	Ok
		Validate user account	
		Account Validated	
		User can entry the system	
		If failed, then user (students and lecturer) call	

		administrator to do manual activation	
2	Membersh ip Activation Function	Administrators find number and name of member	Ok
3	Reading e-book Function	Students and lecturers check all e e-book	Ok
		Check based on category	
4	E-Book Managemen t Function	Administrators input new e-book collection	Ok
		Administrators fill the new collection form	
		Administrators save new collection data	
		Administrators changes the data of e-book	
		Administrators changes the data via form	
		Administrators save the changes	
		Administrators delete	
		Notofication/Confirmation	

**CONCLUSION**

From the whole series of research activities that have been carried out, the extreme programming method is suitable for developing systems that are not too large, and the business processes involved are not complex. In this case, it is suitable for developing a digital library system.

With the research output in the form of a prototype of the proposed system, the prototype testing with alpha testing is quite good because from the test results, it can be seen whether the proposed features are following the system requirements.

By utilizing diagrams in UML, the requirements for the system development process can be easily identified as the next stage of research.

This study recommends that it be continued with the development of the system. Then the system to be developed can accommodate

a mobile platform so that it can be accessed via smartphone devices.

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## COLLABORATION OF ANALYTIC HIERARCHY PROCESS AND SIMPLE ADDITIVE WEIGHTING METHODS TO DETERMINE EMPLOYEE SALARY BONUS

Heribertus Ary Setyadi<sup>1\*</sup>; Ahmad Fauzi<sup>2</sup>, Galih Setiawan Nurohim<sup>3</sup>

<sup>1,3</sup>Sistem Informasi; <sup>2</sup>Sistem Informasi Akuntansi

<sup>1,2,3</sup> Universitas Bina Sarana Informatika

[www.bsi.ac.id](http://www.bsi.ac.id)

heribertus.hbs@bsi.ac.id<sup>1\*</sup>, ahmad.fzx@bsi.ac.id<sup>2</sup>, galih.glt@bsi.ac.id<sup>3</sup>



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**Abstract**— Improving the quality of employee performance, a company needs motivation in the form of giving employee bonuses. Bonuses are additional wages given to employees for achieving the best work that has been done in a period. The environmental service of Sragen has implemented a bonus for its employees, however, the bonus has not been assessed based on supporting criteria so that it is not considered objective. This research was made to be able to help determine employee bonuses more objectively by using several criteria that became the basis for giving bonuses. The criteria used are cooperation, behavior, attendance, performance, service and adaptation. The Analytic Hierarchy Process (AHP) and Simple Additive Weighting (SAW) methods are used in this study so that the bonus calculation can be more objective. The results of the weights from the AHP will be used as a reference for the calculation of SAW. The decision support system is developed using Java programming. The system created can produce recommendations for the amount of bonuses received by each employee. So the resulting bonus value is adjusted to the weight given by AHP. The bonus received by each employee according to the previously inputted data is : Cahyo Winarto received Rp. 1.753.772, Mugi Margo : Rp. 1.156.010, Jarwo : Rp. 1.649.858, Suprandi : Rp. 1.175.984 and Anggoro received Rp. 1.322.826.

**Keywords:** AHP method, SAW method, employee salary bonus

**Intisari**— Dalam meningkatkan kualitas kinerja karyawan suatu perusahaan atau instansi perlu adanya motivasi berupa pemberian bonus karyawan. Bonus upah atau gaji merupakan uang tambahan yang diberikan kepada karyawan atas pencapaian pekerjaan terbaik yang telah dilakukan dalam suatu periode. Dinas Lingkungan Hidup

Sragen sudah menerapkan pemberian bonus bagi karyawannya, hanya saja pemberian bonus belum menggunakan penilaian berdasarkan kriteria-kriteria penunjang sehingga dirasa belum obyektif. Kriteria yang digunakan dalam penelitian ini antara lain kerjasama, perilaku, absensi, kinerja, pelayanan dan adaptasi. Penelitian ini dibuat dengan tujuan untuk dapat membantu menentukan bonus karyawan dengan lebih obyektif yaitu menggunakan beberapa kriteria yang menjadi dasar pemberian bonus. Metode *Analytic Hierarchy Process* (AHP) dan *Simple Additive Weighting* (SAW) digunakan dalam penelitian ini agar perhitungan bonus dapat lebih obyektif. Hasil bobot dari AHP akan dijadikan acuan untuk perhitungan SAW. Sistem pendukung keputusan dibuat menggunakan pemrograman Java. Sistem yang dibuat dapat menghasilkan rekomendasi besaran bonus gaji yang diterima masing-masing karyawan. Jadi nilai bonus yang dihasilkan disesuaikan dengan bobot yang diberikan oleh AHP. Bonus yang diterima oleh masing-masing pegawai sesuai dengan data yang telah diinput sebelumnya adalah Cahyo Winarto menerima Rp. 1.753.772, Mugi Margo: Rp. 1.156.010, Jarwo : Rp. 1.649.858, Suprandi : Rp. 1.175.984 dan Anggoro menerima Rp. 1.322.826.

**Kata Kunci:** metode AHP, metode SAW, bonus karyawan.

### INTRODUCTION

In an effort to realize the environmental condition of Sragen city as a city that is comfortable to live in, productive and sustainable, it is time to pay sufficient attention to the existence of green open spaces. Based on the data of field employees who are tasked with maintaining and caring for the

Sragen city environment, there are 65 field employees whose duties include the fleet, cleaning the highway (Patrol Crew), waste processing, garden cleaning (Park Crew), city sweepers.

The system for determining the award of bonuses to environmental service employees of Sragen is still done manually, namely the process of evaluating employee performance carried out by the administration and managers by checking one by one the criteria that are used as basic guidelines and the process starts from selecting, weighing until determine and decide which employees deserve to be given a bonus in one year of work. The assessment process takes a long time, not to mention entering the wrong criteria value (Yulisman and Wahyuni 2021).

Bonuses are additional payments in addition to salaries or wages that are intended to stimulate incentives so that workers can carry out their duties better and more responsibly, with the hope of higher profits. The higher the profit earned by the company, the greater the bonus given to workers. Not all companies or agencies in Indonesia provide bonuses to employees. This bonus salary is usually issued at the initiative of the company leader (Brata and Whidyanto 2017). Giving a bonus is a form of appreciation from the company for employee performance, the amount of appreciation from the company can be seen by the amount of value given to employees who have worked for a long time. Currently, there are still many companies that do not appreciate the performance of their employees on the grounds that it can interfere with company income and can damage company finances. On the other hand, giving bonuses can actually increase employee performance and can be a separate motivation for each employee, giving bonuses has become a company obligation that must be paid to employees (Subagio, Sokibi and Hartoyo 2019). Besides that, there are many companies that have given awards to employees by giving bonus wages or salaries based on employee performance which is considered satisfactory by the company with the aim of motivating employees to work even harder (Stevanus, Handayani and Kristiyanti 2018).

The purpose of this research is to present a system to help determine the bonuses for field employees of environmental service Sragen. The method used is AHP and SAW. By combining the two methods of AHP and SAW, the system that will be created can produce recommendations for bonuses that will be accepted. By using the criteria that have been determined in this study, it is expected to produce more objective wage bonus information.

Analytical Hierarchy Process (AHP) is a method solve a complex problem structured into a hierarchical arrangement, by assigning which is subjective to each variable relatively. Process

Decision making is basically choosing a best alternative (Saputra & Bachtiar, 2021). This decision support model will describe a complex multi-factor or multi-criteria problem into a hierarchy. What is the role of the matrix in determining priorities and how to establish consistency. AHP is widely used to express a very effective decision making from a complex problem (Alif, Arlingga, Suciati and Priambodo 2021).

The Simple Additive Weighting (SAW) method is based on the average. The SAW method is often used as an assessment method related to decisions in various ways attribute. The evaluation score is calculated for each alternative by multiplying the scale value given to the attribute alternatives by the relative importance of the weight given directly by the decision maker followed by adding up the products for all criteria (Fathoni, Darmansah and Januarita 2021). The SAW method requires a matrix normalization process decision (X) to a comparable scale with all available alternative ratings. SAW method often Also known as the weighted addition method. Draft The basis of the SAW method is to find the weighted sum of performance rating on each alternative on all attributes (Yulianingsih and Ependi, 2020).

In the research entitled *Sistem Pendukung Keputusan Menentukan Pemberian Bonus Tahunan Pada Karyawan Menggunakan Metode Analytical Hierarchy Process (AHP)*, the criteria used include: work results in a year, length of work, number of consumers and warning letters. The number of alternatives or employees used for the calculation is only five people. Of the five people obtained the order: Rudi : 0.31, Agus : 0.19, Rahmat : 0.14, Bima : 0.22 and Ujang : 0.15. So it is recommended to get an annual bonus is Rudi because Rudi has the highest rank or value compared to other prospective employees. The results of the AHP calculation are only limited to who is entitled to a bonus (Saefudin and Farhan, 2019).

The study entitled *Penerapan Metode Analytical Hierarchy Process Dalam menentukan Gaji Bonus Karyawan Pada PTPN III Sei Putih*, performed calculations using the AHP method to determine the priority order of employee bonus salaries. The criteria used are only three: length of working, position and class. there are five alternatives used, they are : presence, work discipline, responsibility, confidence, team work. The order of priority on the resulting bonus salary is: confidence (0.336), work discipline (0.221), team work (0.214), presence (0.176) and responsibility (0.109) (Fadillah, Dur and Cipta 2021).

Research conducted by Nababan & Rahim with the title *Sistem Pendukung Keputusan Reward Bonus Karyawan Dengan Metode TOPSIS*, only performs calculations using the TOPSIS method.

The criteria used include absenteeism, behavior, achievement and teamwork. From the twenty employees who became alternatives, a ranking was made and five peoples were taken who were entitled to get a bonus. The five employees are Niko (0.800981), Rikanto (0.69051), Hermansyah (0.69051), Rasyid (0.577268) and Syakeh (0.537239) (Nababan and Rahim 2018).

Research entitled *Metode Weighted Product Pada Sistem Pendukung Keputusan Pemberian Bonus Pegawai Pada CV Bejo Perkasa*, only performs calculations using the WP method. The criteria used include creativity, attendance, professionalism, cleanliness, cooperation, responsibility, manners and appearance. The number of alternatives used is ten employees. The result of the calculation of WP is a ranking of ten employees and determined three employees who get a bonus. The three employees are ridwan (0.1077), Andi (0.1056) and Pitri (0.1051) (Sugiarto, Rizky, Susilowati, Yunita and Hakim 2020).

From previous research, all only use one method in the decision support system. By using 2 methods will be able to produce recommendations that are more objective. The combination of the 2 methods can complete the shortcomings of the methods used previously. Several studies that have been conducted have not created a system so they only perform calculations using tools.

## MATERIALS AND METHODS

### 1. Collecting Data Method

#### a. Observation

This research is motivated by a lack of objective in giving bonuses because no definite criteria have been determined. Preliminary observations were carried out by obtaining information from environmental service officers and functionary of Sragen environmental service. This step is taken to get a real description of the problems that exist in the awarding of bonuses that have occurred so far.

#### b. Interview

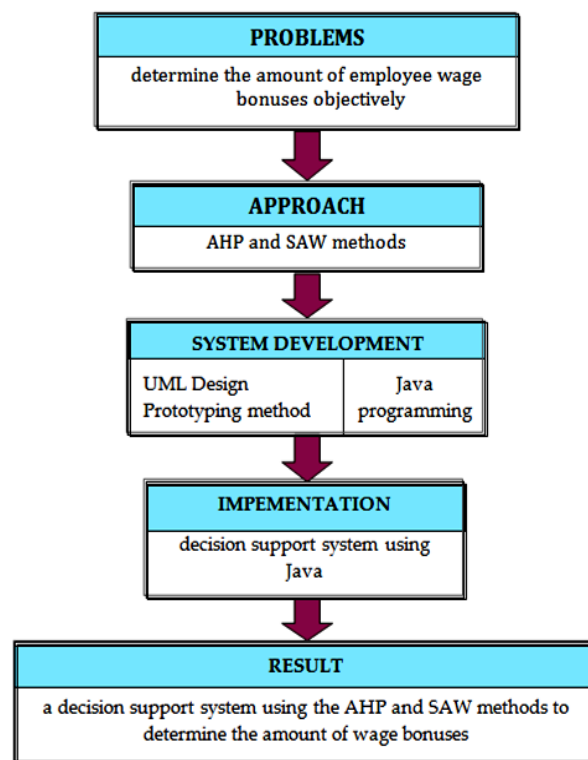
This interview activity is included in the observation stage. Interviews were conducted to obtain additional information about the policy for awarding bonuses. Information on policies that have been in effect so far is obtained from functionary of Sragen environmental service.

#### c. Literature Study

This stage is carried out to collect various information related to this research. The literature used in this study relates to decision support systems, methods in DSS, wages, bonuses and java programming. Previous research is used to compare with this study. Scientific research journals are the

dominant form of literature used in this research (Fridayanthie, et al., 2020).

The conceptual framework of the research can be seen in Figure 1 :



Source : (Setyadi, Fauzi and Nurohim 2021)  
Figure 1. Conceptual Framework

The initial stage of this research is to identify problems in determining employee bonuses for environmental service employees of Sragen. The identification results are formulated to be completed in this study. This identification stage consists of preliminary observations and identification of problems and research purposes. Identification of the problems involved in determining the amount of the bonus based on preliminary observations. This step is useful so that the problems discussed can be more focused so as to facilitate the implementation of the research and there are no deviations from the main objectives of this research.

### 2. System Development Method

At this stage, the system design is carried out so that it can become an application that can function as expected. Some of the stages carried out in this activity are:

a. Data Collection And Processing: At this stage the collection and processing of the data used to design the DSS for determining the amount of the bonus is carried out. The data used is six criteria; cooperation, behavior, absenteeism, performance, service and adaptation as well as data related to the

six criteria.

b. System Analysis and Design: This stage analyzes the weaknesses of the current system, analyzes the needs of the system to be built and defines the needs that must be met by the system to be built. After analyzing the next phase is system design. In the design stage, a design is made that can describe the workflow of the system to be built, the design of the parts that will be worked on in making the system (Agustina and Sutinah 2021).

c. System Implementation: At this stage, data processing will be carried out for the ratio of the importance of the criteria to be selected to the matrix creation according to the method used which is written in a programming language. The development of a decision support system is also carried out at this stage which includes the input of the interest ratio as well as making calculations according to the stages in AHP and SAW. The AHP method is commonly used to solve multi-criteria problems because it uses a hierarchical structure consisting of goals or objectives, criteria, sub-criteria, and alternatives. The SAW method is used to calculate the final alternative value, namely to calculate the bonus according to the weight generated from the AHP method (Fadilah, Nabilah, Juanita and Larasati 2021). The database management system is used to accommodate and manage the data required by the system developed in this research.

d. Evaluation: In this stage, testing is carried out on the level of success and effectiveness of the system built and an analysis of the results of the evaluation is carried out.

## RESULTS AND DISCUSSION

Based on the system design in the previous research methodology, this research produces a decision support system using the AHP and SAW methods to determine the bonus amount using the Java programming language. The weight value used in the SAW method is obtained from the calculation of the AHP method so that the process in this system uses two mutually supportive methods.

Before calculating using 2 methods, first fill in the criteria that will be used. The criteria used can be changed according to the wishes or existing provisions. The display of input criteria data can be seen in figure 2.

ID Kriteria	Nama Kriteria	Argumen Penilaian
1	Kerjasama	Minus
2	Perilaku	Plus
3	Absensi	Plus
4	Kinerja	Plus
5	Pelayanan	Plus
6	Adaptasi	Plus

Source : (Setyadi, Fauzi and Nurohim 2021)  
 Figure 2. Criteria Input Form

The alternative used in this case is that environmental service Sragen employees must also be included first. The form for inputting employee data is shown in figure 3.

ID	Nama Karyawan	Tempat Tugas	Alamat	Tempat Lahir	Tgl lahir	Telp
1	Jarwo Sukadimejo	Armada	Suruh wangan Rt...	Gawok	12-05-1970	085633251478
2	Mugi Margo Utomo	KRU Patroli	Mbayun Rt 15 Rw...	Jelis	08-01-1965	08212324001
3	Cahyo Winarto	KRU Taman	Sogan Tanggan...	Mondokan	18-09-1976	087866223293
4	Suprandi	Tossa Rute Ahm...	Srawung Rt 4 Gesi	Jambeyan	03-12-1967	083365639112
5	dirga bayu	armada	sragen	bandung	12-11-1994	887899
6	fauzi	taman	mojo muljo	sragen	12-06-1994	229811

Source : (Setyadi, Fauzi and Nurohim 2021)  
 Figure 3. Employee Input Form

After the criteria and alternatives are entered, then input the weight values for all employees on each criterion. Weight or value input form is shown in figure 4.

ID Alternatif Kriteria	ID Alternatif	ID Kriteria	Nilai	Nama Alternatif	Nama Kriteria
1	1	1	8.2	Jarwo Sukadimejo	Kerjasama
2	1	2	9.4	Jarwo Sukadimejo	Perilaku
3	1	3	8.4	Jarwo Sukadimejo	Absensi
4	1	4	9.3	Jarwo Sukadimejo	Kinerja
5	1	5	8.2	Jarwo Sukadimejo	Pelayanan
6	1	6	7.4	Jarwo Sukadimejo	Adaptasi
7	2	1	7.3	Mugi Margo Utomo	Kerjasama
8	2	2	8.1	Mugi Margo Utomo	Perilaku
9	2	3	10	Mugi Margo Utomo	Absensi
10	2	4	10	Mugi Margo Utomo	Kinerja
11	2	5	6.3	Mugi Margo Utomo	Pelayanan
12	2	6	8.4	Mugi Margo Utomo	Adaptasi
13	3	1	6.4	Cahyo Winarto	Kerjasama
14	3	2	9.3	Cahyo Winarto	Perilaku
15	3	3	7.3	Cahyo Winarto	Absensi
16	3	4	7.8	Cahyo Winarto	Kinerja
17	3	5	9.8	Cahyo Winarto	Pelayanan

Source : (Setyadi, Fauzi and Nurohim 2021)  
 Figure 4. Value Input Form (Weight)

For the calculation of the AHP and SAW methods, it is presented in 1 form consisting of pairwise comparison ratio, the matrix in AHP and the matrix in SAW. A cut of the pairwise comparison ratio is shown in figure 5.

Kerjasama - Perilaku  
 Kerjasama Lebih Penting Perilaku (Nilai=5)

Kerjasama - Absensi  
 Kerjasama Lebih Penting Absensi (Nilai=5)

Kerjasama - Kinerja  
 Kerjasama Lebih Penting Kinerja (Nilai=5)

Kerjasama - Pelayanan  
 Kerjasama Sedikit Lebih Penting Pelayanan (N...

Kerjasama - Adaptasi

	A1	A2	A3	A4	A5	A6
A1	1	1	2	3	4	5
A2	1	1	1	2	3	4
A3	0,5	1	1	1	2	3
A4	0,333	0,5	1	1	1	2
A5	0,25	0,333	0,5	1	1	1
A6	0,2	0,25	0,333	0,5	1	1
Jml	3,283	4,083	5,833	8,5	12	16

Source : (Setyadi, Fauzi and Nurohim 2021)

Divide each element in the column by the appropriate number of columns. From the matrix element values and the number of each column above, the normalization matrix can be calculated by dividing each element in the column by the appropriate number of columns.

Table 2. Normalization Matrix

	A1	A2	A3	A4	A5	A6	weight
A1	0,305	0,245	0,343	0,353	0,333	0,313	0,315
A2	0,305	0,245	0,171	0,235	0,250	0,250	0,243
A3	0,152	0,245	0,171	0,118	0,167	0,188	0,173
A4	0,102	0,122	0,171	0,118	0,083	0,125	0,120
A5	0,076	0,082	0,086	0,118	0,083	0,063	0,084
A6	0,061	0,061	0,057	0,059	0,083	0,063	0,064

Source : (Setyadi, Fauzi and Nurohim 2021)

In table 2, the last column is the number of each row that will be used as the basis for calculating the consistency matrix. The next step is to create a consistency matrix by multiplying the elements in the matrix column with the appropriate criteria weights. The matrix column element referred to here is the initial matrix, namely the comparison matrix table 3.

Table 3. Consistency Matrix

	A1	A2	A3	A4	A5	A6	Sum
A1	0,315	0,243	0,347	0,361	0,338	0,320	1,923
A2	0,315	0,243	0,173	0,240	0,253	0,256	1,481
A3	0,158	0,243	0,173	0,120	0,169	0,192	1,055
A4	0,105	0,121	0,173	0,120	0,084	0,128	0,733
A5	0,079	0,081	0,087	0,120	0,084	0,064	0,515
A6	0,063	0,061	0,058	0,060	0,084	0,064	0,390

Source : (Setyadi, Fauzi and Nurohim 2021)

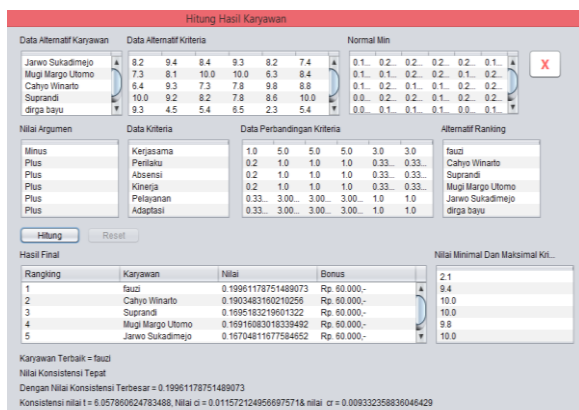
The number of each row above is divided by the corresponding priority, so the calculation is as follows :

- Priority quotient 1 = 1,923/0,315 = 6,1022
- Priority quotient 2 = 1,481/0,243 = 6,1030
- Priority quotient 3 = 1,055/0,173 = 6,0834
- Priority quotient 4 = 0,733/0,120 = 6,0926
- Priority quotient 5 = 0,515/0,084 = 6,0964
- Priority quotient 6 = 0,390/0,064 = 6,0965

The next step is to calculate max by adding up the results of the division in step 6 above and then

Source : (Setyadi, Fauzi and Nurohim 2021)  
 Figure 5. Pairwise Comparison Ratio Form

In the calculation form, the admin will carry out the calculation process with the system using the AHP and SAW methods with input from criteria data and alternative criteria data that are already compatible. Then after that press calculate, the calculation process will automatically run and will display the results of the decision support system for determining employee wage bonuses.



Source : (Setyadi, Fauzi and Nurohim 2021)  
 Figure 6. AHP and SAW Calculation Form

The calculation process is presented in the form of a table or matrix starting from the calculation of the interest ratio, calculating the normalization matrix, making a consistency matrix, calculating the weights in the SAW method to calculating the normalization matrix of the SAW method can be explained as follows :

Table 1. Ratio Of Interest



dividing by the number of elements (n = 8). With the above rules, max can be calculated as follows :  
 $(6,1022+6,1030+6,0834+6,0926+6,0964+6,0965)/6=6,096$ . Calculate the consistency index with a formula  $(\lambda_{max}-n)/(n-1)$ .  $IK=(6,096-6)/5 = 0,019$ .

Calculating the consistency ratio with the  $IK/KR$  formula, where  $KR$  is random consistency worth 1.24 because in this case it has a matrix of size 6.  $RK$  value can be calculated =  $0.019/1.24 = 0.015$ . From the  $RK$  value obtained, the previously obtained sub-criteria weight value can be used because the  $RK$  value is less than 0.1. After the calculation of the AHP method is complete and the results are consistent, the next step is the calculation of the SAW method. The preference weight is the main value that represents the absolute preference of the decision maker (values 1-5), where 1 is very low and 5 is very high based on the level of importance).

Table 4. Weight Criteria SAW

	C1	C2	C3	C4	C5	C6
A1	82	94	84	93	82	74
A2	73	81	10	10	63	84
A3	64	93	73	78	98	88
A4	10	92	82	78	86	10
A5	93	45	54	65	23	54

Source : (Setyadi, Fauzi and Nurohim 2021)

The following steps calculate the SAW normalization table. To determine the value in row 1, column 2 (1,2) and 2,3 the normalization table can be calculated as follows:

$$r_{1,2} = \frac{94}{\max(94,81,93,92,45)} = 1$$

$$r_{2,3} = \frac{10}{\max(84,10,73,82,54)} = 0,119$$

The calculation as above is continued until the last row and column. The results of the normalization matrix are shown in table 5.

Table 5. SAW Normalization Matrix

	C1	C2	C3	C4	C5	C6
A1	0,88	1	1	1	0,84	0,84
A2	0,78	0,862	0,119	0,11	0,64	0,95
A3	0,69	0,989	0,869	0,84	1	1
A4	0,11	0,979	0,976	0,84	0,88	0,11
A5	1	0,479	0,643	0,7	0,32	0,61

Source : (Setyadi, Fauzi and Nurohim 2021)

After the normalized matrix is complete, the next step is to determine the ranking so that the best alternative can be chosen with the following settlement algorithm with weights:

$$V_{A1} = (0,88*0,315) + (1*0,243) + (1*0,173) + (1*0,120) + (0,84*0,084) + (0,84*0,064) = 0,94$$

$$V_{A2} = (0,785*0,315)+(0,862*0,243)+(0,119*0,173) + (0,11*0,120)+(0,64*0,084)+(0,95*0,064) = 0,61$$

$$V_{A3} = (0,688*0,315)+(0,989*0,243)+(0,869*0,173) + (0,84*0,120)+(1*0,084)+(1*0,064) = 0,86$$

$$V_{A4} = (0,108*0,315)+(0,979*0,243)+(0,976*0,173)+ (0,84*0,120)+(0,88*0,084)+(0,11*0,064) = 0,62$$

$$V_{A5} = (1*0,315)+(0,479*0,243)+(0,643*0,173)+ (0,7*0,120)+(0,23*0,084)+(0,61*0,064) = 0,69$$

From the calculated value of  $V$ , it can be determined the amount of bonus wages received by using the basic salary formula (which has been inputted in employee data) multiplied by  $V$ .

$$A1 : 0,94 \times 1.870.000 = 1.753.772$$

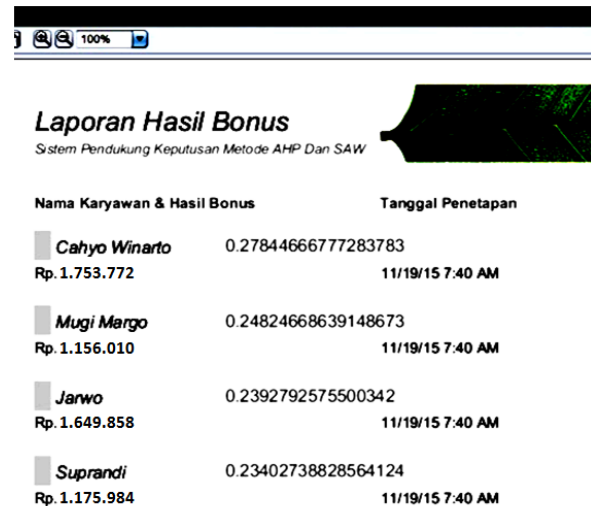
$$A2 : 0,61 \times 1.910.000 = 1.156.010$$

$$A3 : 0,86 \times 1.927.000 = 1.649.858$$

$$A4 : 0,62 \times 1.890.000 = 1.175.984$$

$$A5 : 0,69 \times 1.930.000 = 1.322.826$$

The results of these calculations are presented in the form of a report as shown in figure 7.



Source : (Setyadi, Fauzi and Nurohim 2021)

Figure 7. Bonus Report Form

## CONCLUSION

A Decision Support System has been designed and made which aims to provide recommendations in the decision-making process of employees who will receive salary bonuses from the service. By using the six criteria required by the agency to determine the wage bonus, it is hoped that the amount of the wage bonus will be more objective. In this decision support system there is an alternative value processing that is used as an input for employee value weights which will be processed through the AHP and SAW methods which are then processed to determine the wage bonus to be received. The result of the AHP method is the weight of the six predetermined criteria. The weight produced by the AHP method becomes a reference in the calculation of the SAW method.

The final result of the calculation of the SAW method in the form of the salary bonuses of five employees who have been previously inputted is as follows : Cahyo Winarto received Rp. 1.753.772, Mugi Margo : Rp. 1.156.010, Jarwo : Rp. 1.649.858, Suprandi : Rp. 1.175.984 and Anggoro received Rp. 1.322.826.

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## SATISFACTION ANALYSIS OF RESPONSIVE WEB DESIGN (RWD) USING PIECES METHOD IN YOBAGI: TECHNOLOGY PLATFORM BASED ON SOCIALPRENEURSHIP

Dwi Yuny Sylfania<sup>1</sup>, Rendy Rian Chrisna Putra<sup>2</sup>, Fransiskus Panca Juniawan<sup>3\*</sup>

Teknik Informatika<sup>1,2</sup>  
Institut Sains dan Bisnis Atma Luhur <sup>1,2</sup>  
[www.atmaluhur.ac.id](http://www.atmaluhur.ac.id) <sup>1,2</sup>

Teknologi Informasi<sup>3</sup>  
Universitas Bangka Belitung<sup>3</sup>  
[www.ubb.ac.id](http://www.ubb.ac.id)<sup>3</sup>

[dysylfania@atmaluhur.ac.id](mailto:dysylfania@atmaluhur.ac.id)<sup>1</sup>, [rendyriancp@atmaluhur.ac.id](mailto:rendyriancp@atmaluhur.ac.id)<sup>2</sup>, [fransiskuspj@ubb.ac.id](mailto:fransiskuspj@ubb.ac.id)<sup>3\*</sup>



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**Abstract**— *The Covid-19 pandemic has had a huge impact on society. There have been layoffs for some people, which has an impact on their economy, which is getting worse. Another impact was felt by MSMEs where their transactions also decreased. Yobagi is proposed to overcome this problem by becoming a social entrepreneurship-based media platform that becomes an intermediary media for anyone who has the desire to share their skills, knowledge, and experiences. Yobagi users access the system from various devices, namely mobile and desktop. For this reason, the Responsive Web Design (RWD) function is applied to make Yobagi perform optimally according to the device used by the user. This study aims to analyze the performance of Yobagi's Responsive Web Design system as measured by the PIECES method from the user's point of view and PageSpeed Insight to get RWD performance. The results of the test show that the user is very satisfied with the RWD performance with a score of 6.380 and good for Performance with a score of 83.55.*

**Keywords:** *Socialpreneurship, Yobagi, Responsive Web Design, PageSpeed Insights, PIECES*

### INTRODUCTION

Covid-19 become the biggest factor in the decline in the community's economy (Oeliestina, 2021). One of the reasons is because there are many workers who get laid off from the company where they work (Indayani & Hartono, 2020). This has an impact on increasing the unemployment rate nationally. The people of Pangkalpinang also

experienced these problems (Bangka Belitung, 2022). Likewise, Micro, Small, and Medium Enterprises (MSMEs) are also affected by the pandemic. The important role of MSMEs in the national economy is the reason the Government continues to encourage MSMEs to be rise from economic downturn (Bahtiar, 2021). One of the challenges for MSMEs to be able to rise is related to incentives where not all MSMEs can receive these incentives. In addition, these incentives do not necessarily guarantee the sustainability of MSME businesses. Therefore, Socialpreneurship can be a solution to reduce the gap in the business world with cooperation and mutual help among others (Cakranegara et al., 2020). The socialpreneurship model is a form of entrepreneurship that has the aim of helping the community, which can cover all fields (Sofia, 2017). In addition, the advantage of socialpreneurship is that it can become a business activity by involving innovative resources in making social change, especially young people (Safitri, 2020). For this reason, more social awareness is needed that can support the sustainability of the MSMEs economy and the community.

The socialpreneurship model has been widely applied to various conditions, one of them, which is to support the empowerment of productive villages with a socialpreneur approach with the aim of obtaining additional income for the community (Lathifah & Herlina, 2021). Another example is its application to the tourism sector in the city of Tasikmalaya which can be concluded to be a solution to the pandemic in overcoming community economic problems (Cakranegara et al., 2020).

Socialpreneurship has also been implemented to help the MSMEs economy. Tirta Alam Bumi Bertuah Foundation has successfully implemented entrepreneurship by involving young people in its implementation (Safitri, 2020). Makassar City MSMEs also apply socialpreneurship in their research (Verawaty & Lutfi, 2020).

Based on the spirit of socialpreneurship, Yobagi is proposed to be one of the solutions to solve these problems. Yobagi has some features, likely, the MSME market, Procurement of Goods from MSMEs, and also sharing activities from the community for the community. Yobagi is developed on a web-based system by implementing a Responsive Web Design (RWD) interface for desktop and also mobile users. RWD is used so that users can be more comfortable in accessing the website using a mobile device (Novianty, 2017).

A website must be able to display the website page responsively following the display settings of the access device so that it can display the website according to the device settings. This feature is called Responsive Web Design (RWD) which can be applied to mobile-based devices, such as smartphones, tablets, and netbooks (Pamungkas et al., 2019). Yobagi development has implemented a responsive web function as a solution for users who use mobile devices. To analyze the Yobagi system, a user satisfaction analysis was carried out using the PIECES framework method which can facilitate system evaluation (Nur Fauzi et al., 2022). Previous research analyzed the influence of RWD on website quality using the PIECES method. From the results of the analysis, it is known that the lack of RWD is in the domain of performance and economics (Pamungkas et al., 2019). Another study conducted an analysis of user satisfaction using the PIECES method with the result that on average the system built had very satisfactory results with a score of 4.22 (Syafii et al., 2022). The PIECES method can also be used as a tool in the development of a system because it can describe how the role of the system in helping complete existing work with 6 aspects of PIECES analysis (Fikastiana Cahya et al., 2021). Other studies also use PIECES to analyze the database requirements and user interface of a system (Rahasomar & Hamdani, 2022). This study aims to analyze the performance of Responsive Web Design (RWD) of users using the PIECES method.

## METHODOLOGY

This study uses a methodology consisting of several stages which are described as follows.

### A. Literature Study

At this stage, a literature study is carried out where information and references needed for

research are collected. The sources used are previous research, scientific articles, and primary library sources in the form of books.

### B. Data Collecting

At this stage, the necessary data collection is carried out in conducting research. The data collected was in the form of a questionnaire which was distributed to find the value of Yobagi's user satisfaction in assessing Yobagi's Responsive Web Design (RWD). The questions given to users were then analyzed using the 7-point Likert scale rating criteria as shown in Table 1.

Table 1. Likert Scale

Scale	Description
7	Strongly Agree
6	Agree
5	Quite Agree
4	Netral
3	Quite Disagree
2	Disagree
1	Strongly Disagree

Questionnaires were given to 32 Yobagi users who are the leading MSMEs in Pangkalpinang.

### C. Analysis of Data Collection Results

After completing data collection through questionnaires, the next step is to analyze it using the PIECES Framework method to obtain the average score of the questionnaire. The PIECES Framework method has seven levels of satisfaction which are described in Table 2.

Table 2. Satisfaction Level of PIECES Method

Criteria	Satisfaction Level	Grade
6 - 7	Very Satisfied	A
5 - 5,9	Satisfied	B
4 - 4,9	Quite Satisfied	C
3 - 3,9	Netral	D
2 - 2,9	Quite Dissatisfied	E
1 - 1,9	Dissatisfied	F
0 - 0,9	Very Dissatisfied	G

The indicators used in analyzing the level of user satisfaction are described in Table 3.

Table 3. PIECES Method Indicators

Indicator	Description
Performance	Knowing the performance of a system is good or not
Information	Knowing how much and clearly the information provided

Economics	Knowing whether the system is right to be applied in terms of the financing to be issued
Control	Knowing the extent of supervision and control carried out by the system
Efficiency	Knowing the level of efficiency and effectiveness of the system
Service	Knowing the services provided by the system to users

#### D. System Evaluation

The next stage is the evaluation of the system based on the results of the PIECES Framework method analysis to determine the highest score obtained. The evaluation also uses the PageSpeed Insights tool with the indicators shown in Table 4.

Table 4. PageSpeed Insights Indicators

Indicator	Description
First Contentful Paint (FCP)	An indicator used to calculate the time when a text or image is first shown to the user.
Time to Interactive (TTI)	An indicator used to calculate the time it takes for a ball-man application to become fully interactive.
Speed Index (SI)	An indicator that is used to calculate how fast an application page displays the overall content.
Total Blocking Time (TBT)	An indicator used to calculate the sum of all time periods between the FCP and TTI indicators.
Largest Contentful Paint (LCP)	An indicator used to calculate the time against the largest text or image to be displayed to the user.
Cumulative Layout Shift (CLS)	An indicator that is used to calculate the movement of the layout of a content that is visible to the user.

The pages tested by PageSpeed Insights tool are shown in Table 5.

Table 5. Pages of Yobagi

Code	Description
H1	Login Page
H2	Dashboard Page
H3	Product Page
H4	Eproc Page
H5	Activity Page

H6	Information Page
H7	About Us Page

## RESULTS AND DISCUSSION

### A. System Implementation

The Yobagi system was built using the Bootstrap framework with the aim of getting a user-friendly interface and having Responsive Web Design (RWD) features.

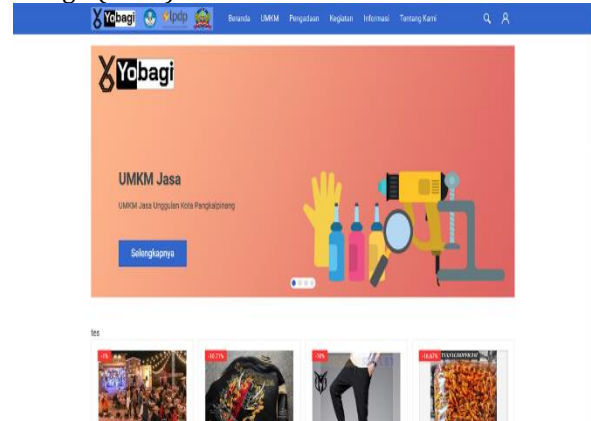


Figure 2. Display of Home page on Desktop

Figure 2 is a display of the home page accessed via browser on a computer desktop device.



Figure 3. Display of Dashboard Page on Smartphone

Figure 3 is display of the home page which is accessed through browser on a smartphone device.

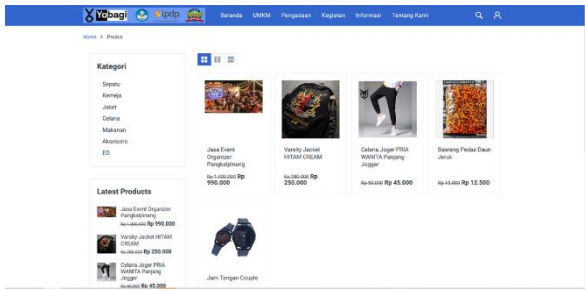


Figure 4. Display of Product page on Desktop

Figure 4 is view of Product Page that displays all MSME products that are accessed from computer browser.



Figure 5. Display of Product page on Smartphone

Figure 5 is a display of the MSME Product Page which is accessed from a smartphone browser.

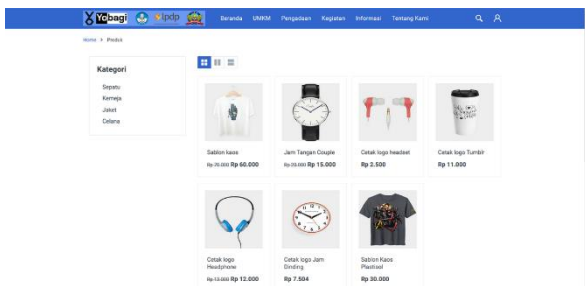


Figure 6. Display of Eproc page on Desktop

Figure 6 is E-procurement page that is accessed from a computer browser. On this page, MSMEs can display any products that the community can choose for their procurement activities.

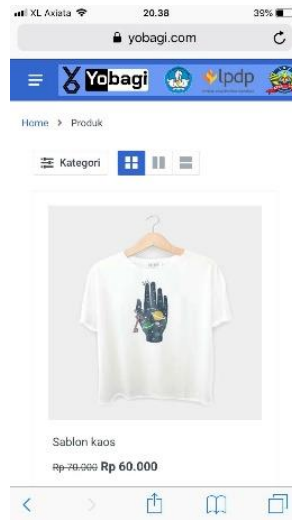


Figure 7. Display of Eproc page on Smartphone

Figure 7 is E-procurement page that is accessed from a smartphone browser.

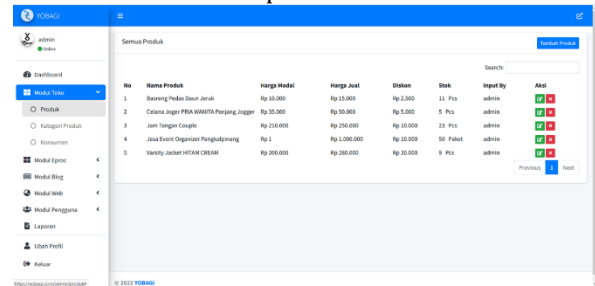


Figure 8. Display of Backend page on Desktop

Figure 8 which is a display of the backend page from the admin side which is accessed from a browser from desktop device.



Figure 9. Display of Backend page on Smartphone

Figure 9 which is a backend page view from the admin side which is accessed from a smartphone's browser.

B. Validity Tests

This test is carried out to find out whether there are items from questions that are not valid. The test is carried out by comparing the value of the *r* calculated questionnaire with the *r* table value. To get valid results, it must meet the conditions *r* count > *r* table. The value of *r* table at a significance of 0.05 with the number of instruments 26 items is 0.388. For *r* count can be seen in Table 6.

The results in Table 6 prove that all the calculated *r* items have a corrected item total value above 0.388, so that all variables of importance can be declared valid.

Table 6. Results of Validity Test

No.	<i>r</i> Count	<i>r</i> table	Description
1	0,571	0,388	Valid
2	0,487	0,388	Valid
3	0,417	0,388	Valid
4	0,619	0,388	Valid
5	0,478	0,388	Valid
6	0,465	0,388	Valid
7	0,392	0,388	Valid
8	0,438	0,388	Valid
9	0,448	0,388	Valid
10	0,467	0,388	Valid
11	0,579	0,388	Valid
12	0,554	0,388	Valid
13	0,426	0,388	Valid
14	0,446	0,388	Valid
15	0,412	0,388	Valid
16	0,395	0,388	Valid
17	0,441	0,388	Valid
18	0,497	0,388	Valid
19	0,553	0,388	Valid
20	0,397	0,388	Valid
21	0,46	0,388	Valid
22	0,413	0,388	Valid
23	0,457	0,388	Valid
24	0,625	0,388	Valid
25	0,533	0,388	Valid
26	0,659	0,388	Valid

C. Reliability Tests

So that the results of the questionnaire answers used in a study can be trusted as a data collection tool, it can be tested with reliability tests. In a questionnaire, it can be said to be reliable or trustworthy if the respondent's answers to the questionnaire questions are stable or consistent (Nur Fauzi et al., 2022). Measurement of reliability test is shown in the form of a number called the value of the reliability coefficient. If the value of the

reliability coefficient is close to 1, then the questionnaire has high reliability. In general, the level of reliability can be considered sufficient in carrying out the test if it exceeds the value of 0.7 (Firmansyah, 2021).

Table 7. Case Processing Summary

	N	%
Cases		
Valid	32	100.0
Excluded <sup>a</sup>	0	.0
Total	32	100.0

a. Listwise deletion based on all variables in the procedure.

Table 7 proves that the test results of respondents with a total of 32 respondents are valid with a value of 100%.

Table 8. Reliability Measurement Results

Cronbach's Alpha	N of Items
.855	26

Based on Table 8, it can be seen that the value of Cronbach's Alpha has a value of 0.855. Because the Cronbach's Alpha value is 0.855 > 0.349 *r* table, then this shows that the reliability testing of the results of the questionnaire can be accepted and trusted.

D. Analysis of PIECES Method

To perform PIECES method analysis, this study uses the PageSpeed Insights webtool with the interface shown in Figure 10.

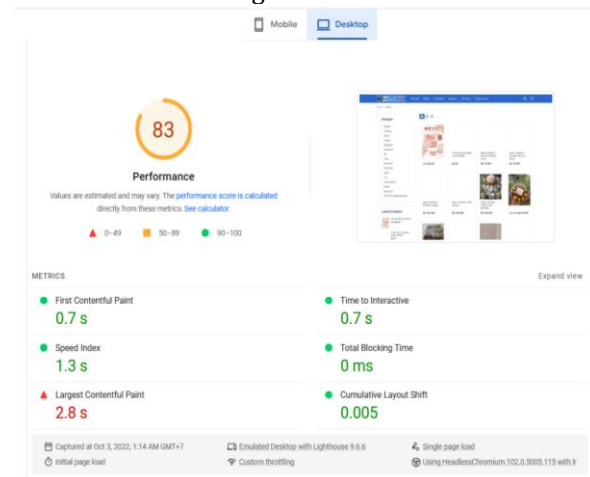


Figure 10. PageSpeed Insights

Table 9 describes the results of testing all Yobagi pages using the PageSpeed Insights webtool. There are six indicators used by PageSpeed Insights, namely First Contentful Paint, Time To Interactive,

Speed Index, Total Blocking Time, Large Contentful Paint, and Cumulative Layout shifts.

From the table 9, it can be seen that the average score obtained by Yobagi has a value of 78.1 for mobile devices and 89 for desktop devices. The average indicators obtained are 2.58 seconds for FCP (First Contentful Paint) mobile devices and 0.7 seconds for desktop devices, 5.36 seconds for TTI (Time To Interactive) mobile devices and 0.7 seconds for desktop devices. Furthermore, there is

Table 9. PageSpeed Insights Results

Code	FCP		TTI		SI		TBT		LCP		CLS		Performance	
	M	D	M	D	M	D	M	D	M	D	M	D	M	D
H1	2,6	0,7	4,1	0,7	2,6	0,7	20	0	3,5	0,7	0,001	0,005	86	99
H2	2,6	0,7	5,5	0,7	11,7	4,8	100	0	11,5	2,9	0	0,005	58	74
H3	2,6	0,7	4,1	0,7	2,6	1,3	20	0	3,2	2,8	0	0,005	88	83
H4	2,6	0,7	5,5	0,7	2,6	0,7	30	0	3,8	1,2	0	0,005	82	97
H5	2,6	0,7	12	0,7	2,6	0,8	120	0	9,8	1,8	0,532	0,187	49	87
H6	2,6	0,7	3,8	0,7	2,6	0,7	10	0	2,7	2,6	0,004	0,089	91	84
H7	2,5	0,7	2,5	0,7	2,5	0,7	0	0	2,6	0,8	0	0,005	93	99
Σ	2,58	0,7	5,36	0,7	3,88	1,38	42,9	0	4,76	1,83	0,08	0,043	78,1	89
	s	s	s	s	s	s	ms	ms	s	s				

From the results of the questionnaire data that has been distributed to 32 leading MSMEs actors in Pangkalpinang City, the results of measuring the level of user satisfaction with the Yobagi system have been obtained. The indicators used to analyze the level of user satisfaction using the PIECES Framework method. This method uses six indicators, namely, performance, information, economic, control, efficiency, and service. Calculation using equation 1.

$$\text{Average Score} = \frac{\sum RK}{n} \dots\dots\dots(1)$$

$$\text{Average Score} = \frac{6,531 + 6,469 + 6,156 + 6,375 + 6,344 + 6,406}{6}$$

$$\text{Average Score} = 6,380$$

From the calculation using equation one, the average score for each aspect in the PIECES method is obtained with a value of 6.380. Furthermore, by looking at the table, Yobagi can be declared Very Satisfied by the users.

## CONCLUSION

From the results of the questionnaire analysis on the satisfaction of using RWD with the PIECES method on Yobagi, a score of 6.380 was obtained which can be stated as Very Satisfied. This means that Yobagi users are very satisfied with the performance of Yobagi's Responsive Web Design (RWD). Furthermore, from the Yobagi test on the PageSpeed Insights web tool, it has a Performance value of 78.1 for mobile devices and 89 for desktop

the SI (Speed Index) indicator getting a value of 3.88 seconds for mobile devices and 1.38 seconds for desktop devices, 42.9 milliseconds for TBT (Total Blocking Time) for mobile devices and 0 milliseconds for desktop devices, 4,76 seconds for LCP (Large Contentful Paint) mobile devices and 1.83 seconds for desktop devices, and the last 0.08 for CLS (Cumulative Layout Shift) mobile devices and 0.043 for desktop devices.

devices which on average gets a score of 83.55. This means that the performance of all pages on the Yobagi system is in the good category.

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## IMPLEMENTATION OF THE WEIGHT PRODUCT METHOD IN THE SYSTEM NEW STUDENT ADMISSION

Siti Nurhasanah Nugraha <sup>1</sup>; Rangga Pebrianto <sup>2</sup>; Fani Nurona Cahya <sup>3</sup>; Irwan Herliawan <sup>4</sup>

<sup>1</sup> Information Systems  
Universitas Nusa Mandiri  
[nusamandiri.ac.id](http://nusamandiri.ac.id)  
<sup>1</sup> [siti.nhg@nusamandiri.ac.id](mailto:siti.nhg@nusamandiri.ac.id)

<sup>2,3</sup> Information System  
Universitas Bina Sarana Informatika  
[bsi.ac.id](http://bsi.ac.id)  
<sup>2</sup> [rangga.rpo@bsi.ac.id](mailto:rangga.rpo@bsi.ac.id), <sup>3</sup> [fani.foc@bsi.ac.id](mailto:fani.foc@bsi.ac.id)

<sup>4</sup> Informatics  
Universitas Nusa Mandiri  
[nusamandiri.ac.id](http://nusamandiri.ac.id)  
<sup>4</sup> [irwan.ien@nusamandiri.ac.id](mailto:irwan.ien@nusamandiri.ac.id)



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**Abstract** — The development of information technology is something that cannot be separated from life today. The development of information technology, especially the internet, is certainly welcomed by all circles, and has even penetrated the world of education since the last few years, thus creating competitive competition in every educational institution. Currently, there are not many schools in Indonesia that hold new student admissions (PPDB) by utilizing the online system. Of course, this will take a very long time, because after selecting the prospective students, the committee must recap the names and grades of the students accepted. We need a system that will support decisions in the selection of new student admissions so that the resulting output is more accurate. To solve this problem, it is necessary to have a decision support system for the selection process for new admissions using the Weight method Products . From the results of calculations with 4 criteria, namely C1 Mathematics, C2 English, C3 Indonesian and C4 Tadarus which were applied to 4 alternative students as samples, it showed that students who had a vector value of more than 0.250 were declared to have passed the PPDB selection. And from the results of calculations that have been carried out there are 3 students who have passed the selection, while 1 student is declared not to have passed the selection. With this method the PPDB selection calculation will be more objective because the

calculation is based on predetermined weights and assessment criteria. So that the creation of an optimal system that will facilitate the PPDB selection process.

**Keywords** : New Student Admission , Decision Support System , Weight Products.

**Intisari** — Perkembangan teknologi informasi merupakan suatu hal yang tidak lepas dari kehidupan saat ini. Perkembangan teknologi informasi khususnya internet tentunya disambut dengan baik oleh semua kalangan, bahkan telah merambah ke dunia pendidikan sejak beberapa tahun terakhir, sehingga menciptakan persaingan yang kompetitif di setiap lembaga pendidikan. Saat ini belum banyak sekolah di Indonesia yang menyelenggarakan penerimaan peserta didik baru (PPDB) dengan memanfaatkan sistem online. Tentunya hal ini akan membutuhkan waktu yang sangat lama, karena setelah menyeleksi calon siswa tersebut panitia harus merekap ulang daftar nama dan nilai siswa yang diterima. Diperlukannya sebuah sistem yang akan mendukung keputusan dalam seleksi penerimaan peserta didik baru sehingga output yang dihasilkan lebih akurat. Untuk memecahkan masalah tersebut diperlukan adanya suatu sistem pendukung keputusan proses seleksi penerimaan siswa baru dengan menggunakan metode Weight Product. Dari hasil perhitungan

dengan 4 kriteria yaitu C1 Matematika, C2 Bahasa Inggris, C3 Bahasa Indonesia dan C4 Tadarus yang diterapkan pada 4 alternatif siswa sebagai sampel menunjukkan bahwa siswa yang memiliki nilai vektor lebih dari 0.250 dinyatakan lulus seleksi PPDB. Dan dari hasil perhitungan yang telah dilakukan terdapat 3 siswa yang dinyatakan lulus seleksi, sementara 1 siswa dinyatakan tidak lulus seleksi. Dengan metode ini perhitungan seleksi PPDB akan lebih objektif karena perhitungan berdasarkan bobot dan kriteria-kriteria penilaian yang telah ditentukan. Sehingga terciptanya sebuah sistem optimal yang akan mempermudah proses seleksi PPDB.

**Kata Kunci :** Metode Weight Product, Penerimaan Peserta Didik Baru, Sistem Pendukung Keputusan.

## INTRODUCTION

The development of information technology is something that cannot be separated from life today. With the information, it is possible to make the right decision to do a plan and can make it easier to manage company activities effectively and efficiently (Prasetyo et al., 2018). The development of information technology, especially the internet, is certainly welcomed by all circles, and has even penetrated the world of education since the last few years (Witanto & Solihin, 2016). This of course creates competitive competition in every educational institution.

Currently, there are not many schools in Indonesia that hold new student admissions (PPDB) by utilizing the *online system*. According to (Budiarti et al., 2018), "the existence of a computerized system can help convey information and facilitate the implementation of processing and managing new student admission data." With these benefits and conveniences, this system should be developed by each school. This is in line with advances in information and communication technology that is able to support input and output processes quickly and accurately, especially in the implementation of PPDB (Budiarti et al., 2018).

One of the academic activities in the school is the New Student Admission (PPDB) process which is carried out every time before the new school year. In the process of accepting new students, some schools still use the manual method which is divided into several parts. Each student who registers must fill out a registration form first, then the PPDB committee will select each form that is filled out by the candidate or the student's guardian. Of course, this will take a very long time, because after selecting the prospective students, the committee must recap the names and grades of the students accepted.

This manual system also certainly results in the administration process of new student admissions tending to be slow, because the data of new students who have registered have not been integrated and managed properly. So that the need for a concept and mechanism for accepting new students by utilizing information technology is one thing that really needs to be considered.

Research that discusses the *online new student admission system* has been done before. Research by (Ruhul Amin, 2017) with the title Design and Build a New Student Admission System at SMK Budhi Warman 1 Jakarta, in his research revealed that an *online -based registration system* can make it easier for prospective new students to register by saving time and costs compared to coming directly to the school, and can help and facilitate the management of new students at the school. In this study the author will apply the *Weight Product* method as a method in making decisions because based on research conducted by (Syafitri et al., 2019), this method can provide a solution to the selection of laptops. Decision Support System (DSS) is an information system that uses decision models, databases, and managers' own thinking, interactive *modeling processes* with computers to achieve decision making by certain managers. With the DSS, it can provide interactive tools that allow *decision makers* to carry out various analyzes of the model in question". (Utomo, 2015).

Research conducted by (Noer, 2019) resulted in a computerized sub-system of new student admissions that can facilitate the process of accepting new students. The research by (Niza, 2019) resulted in a decision support system for the selection of new admissions with a *weight product method* based on *Visual Basic Net 2010* which can select computerized students quickly, accurately and efficiently. Research by (Fauzan et al., 2017) resulted in a computerized system that can help the process of majoring and accepting new students quickly, accurately and efficiently with the *Weight Product method*.

Based on this, it is necessary to have a system that can manage the process of accepting new students so that the process of implementing new student admissions can run effectively and efficiently. It is hoped that the existence of this system can simplify and speed up the process of accepting new students, so as to facilitate employee performance.

## MATERIALS AND METHODS

The stages of the research include the steps taken from beginning to end, as follows:

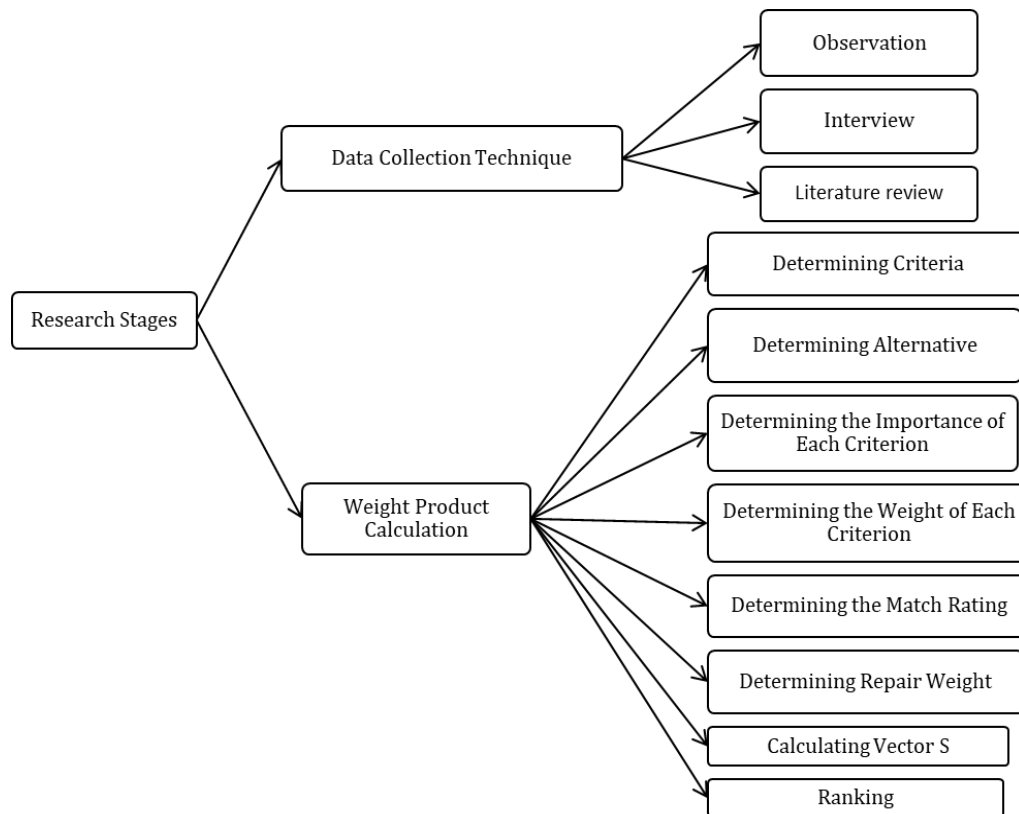


Figure 1. Research Stages

The explanation of the stages of the research carried out is as follows:

A. Data Collection Techniques

1. Observation

The author collects data and information by observing directly how the PPDB system is implemented in one of the schools, namely SMK Singaparna.

2. Interview

Here, the author conducts direct interviews with Mrs. Yuli Sumartini, ST as the Administration in the Administration section at SMK Singaparna and as one of the PPDB committees.

3. Literature Study

In this way, the authors collect supporting data for this study by taking several references from books, journals, proceedings and from the internet to obtain materials related to the research made.

B. Weight Product Method

According to (Niswatin, 2017), the *product weight method* uses multiplication to connect attribute ratings, where the rating of each attribute must first be raised to the weight of the attribute in question. This process is the same as the normalization process. The preference for alternative  $A_i$  is given as follows:

$$S_i = \prod_j^n = 1X_{ij}^{w_j} \dots \dots \dots$$

Where  $i = 1, 2, 3, \dots, n$ . Where  $w_j = 1$ ,  $w_j$  is a positive rank for the profit attribute, and a negative value for the cost attribute. The relative preferences of each alternative are given as follows:

$$V_i = \frac{\prod_j^n = 1X_{ij}^{w_j}}{\prod_j^n = 1(X_i)^{w_j}} \dots \dots \dots$$

With  $i = 1, 2, 3, \dots, n$ .

Where :

V = Alternative preferences analogous to a vector V

x = Criteria value

w = Weight of criteria/subcriteria

i = Alternative

j = Criteria

n = Number of criteria

\* = The number of criteria that have been assessed on Vector S.

**RESULTS AND DISCUSSION**

A. System Procedure

Prospective students come directly to Singaparna Vocational School to register. Then prospective students will make a selection according to the specified schedule. The selections

included tests of general knowledge, Mathematics, English, and Tahfidz Al-Qur'an.

After the selection process is complete, the committee that acts as the system admin will input the results of the selection into the system. Then the system will process the calculation of the selection results in accordance with what was input by the admin. The system will display the results of the calculations used as the result of the selection process.

### B. System Requirements Analysis

Functionality requirements are descriptions of activities or services that must be provided by the application to be made. In the design of the new student admissions information system there are two users, namely admin and user. The admin and user have the following characteristics and needs:

1. Admin Needs
  - a. Admin can login.
  - b. Admin can input, delete, and edit prospective student data.
  - c. Admin can input criteria data for assessment.
  - d. Admin can input value in *Weight Product calculation*.
  - e. Admin can make reports as needed.
  - f. Admin can log out of the system by logging out.
2. User Needs
  - a. Users can login.
  - b. Users can see announcements of new student admissions.
  - c. Users can exit the system by logging out.
3. System Requirements
  - a. The system can manage the data of prospective students.
  - b. The system can manage criteria data.
  - c. The system can manage *weight product calculations* for new student admissions.
  - d. The system can manage reports.
  - e. Admin and user must log out after using the application.
4. Calculation of *Weight Product Method*

The process of calculating new student admissions using the WP method can be implemented as follows:

  - A. Determining the Assessment Criteria
    - C1 : MATHEMATICS
    - C2 : ENGLISH
    - C3 : INDONESIAN LANGUAGE
    - C4 : TADARUS
  - B. Determining Alternative
    - A1 : Doni
    - A2 : Aji
    - A3 : Anisa
    - A4 : Widya
  - C. Determining the Level of Importance of Each Criterion

Table 1. The Level of Importance of Each Criterion

LEVEL OF INTEREST	SCORE
Not too important	1
Quite important	2
Very important	3

### D. Determining the Preference Weight of Each Criterion

Table 2. Weight of Preference for Each Criterion

CRITERIA	DESCRIPTION	WEIGHT
C1	MATHEMATICS	2
C2	ENGLISH	3
C3	INDONESIAN	2
C4	TADARUS	3

### E. Determining the Suitability Rating of Each Alternative On Each Criterion

Table 3. Rating of the suitability of each alternative on each criterion

ALTERNATIVE	CRITERIA			
	C1	C2	C3	C4
A1	70	80	77	80
A2	80	88	78	82
A3	83	78	89	90
A4	78	92	85	80

### F. Determining Repair Weight

$$W1 = \frac{2}{(2+3+2+3)} = 0,2$$

$$W2 = \frac{3}{(2+3+2+3)} = 0,3$$

$$W3 = \frac{2}{(2+3+2+3)} = 0,2$$

$$W4 = \frac{3}{(2+3+2+3)} = 0,3$$

Table 4. Improvement of the Weight of Each Criterion

CRITERIA	SCALE OF INTEREST	WEIGHT REPAIR
C1	2	0.2
C2	3	0.3
C3	2	0.2
C4	3	0.3

### G. Calculating Vector S

$$S1 = (70^{0.2})(80^{0.3})(77^{0.2})(80^{0.3}) = 77.30$$

$$S2 = (80^{0.2})(88^{0.3})(78^{0.2})(82^{0.3}) = 82.51$$

$$S3 = (83^{0.2})(78^{0.3})(89^{0.2})(90^{0.3}) = 84.64$$

$$S4 = (78^{0.2})(92^{0.3})(85^{0.2})(80^{0.3}) = 84.02$$

H. Determining Rank

$$V1 = \frac{77,30}{(77,30+82,51+84,64+84,02)} = 0,235$$

$$V2 = \frac{82,51}{(77,30+82,51+84,64+84,02)} = 0,251$$

$$V3 = \frac{84,64}{(77,30+82,51+84,64+84,02)} = 0,258$$

$$V4 = \frac{84,02}{(77,30+82,51+84,64+84,02)} = 0,256$$

Table 5. Ranking Results

Alternative	Results	Rank	Information
V3	0.258	1	Graduated
V4	0.256	2	Graduated

C. Use Case Diagrams

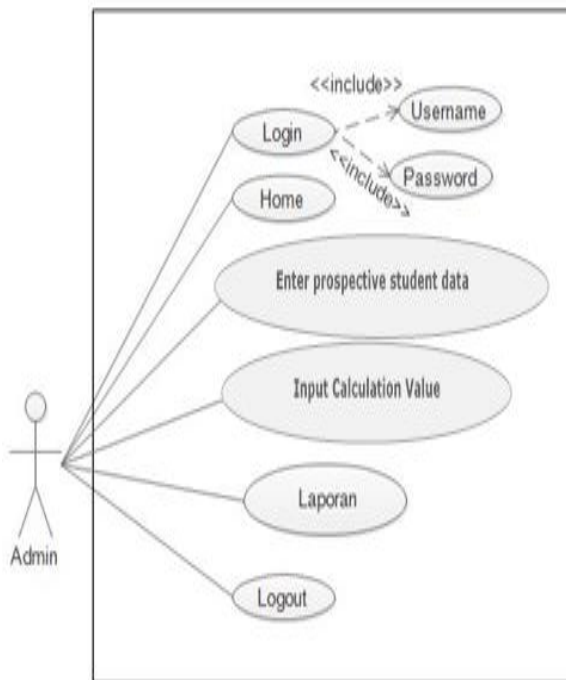


Figure 2. Use Case Diagram Admin

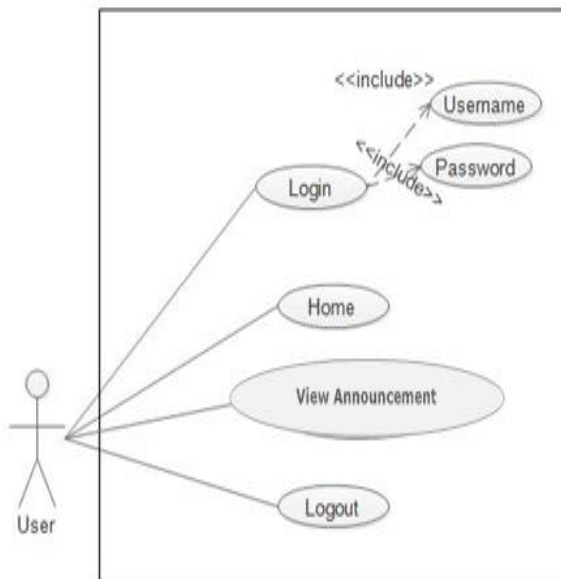


Figure 3. Use Case Diagram User

V2	0.251	3	Graduated
V1	0.235	4	Not pass

Based on the provisions of SMK Singaparna that students who are considered to have passed the selection are students who have a preference value of more than 0.250. And from the calculations that have been done above, it can be seen that there are three students who have a preference value of more than 0.250. This means that the three students passed the selection and were entitled to proceed to the next stage, while 1 student was declared not to have passed the selection.

D. Entity Relationship Diagram (ERD)

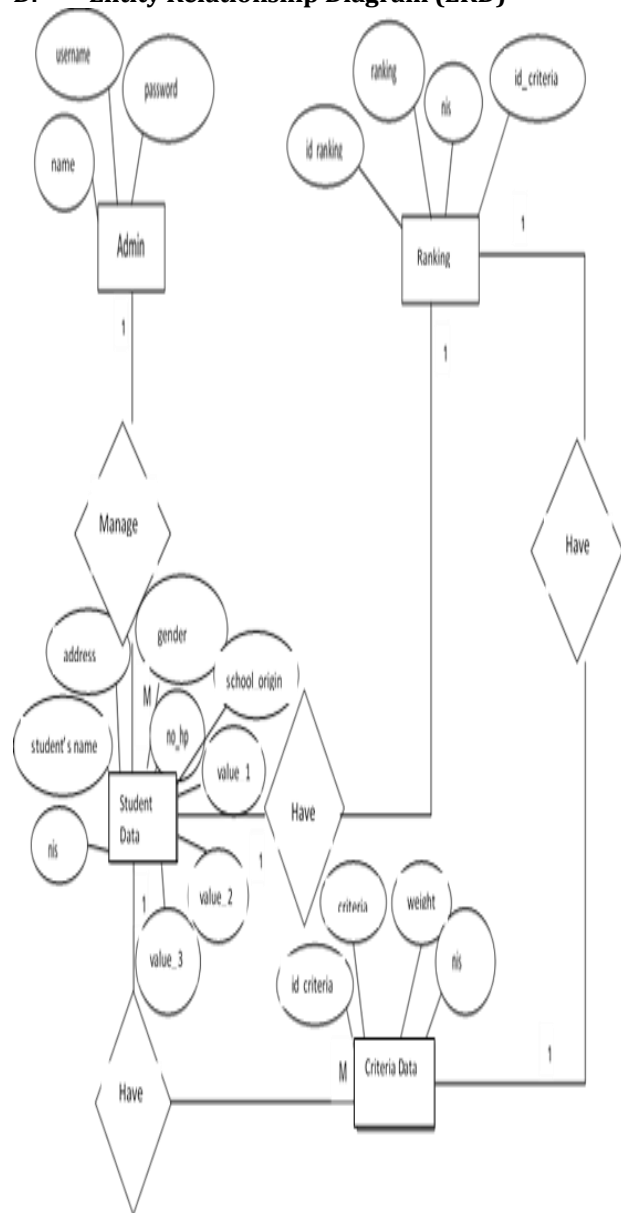


Figure 4. Entity Relationship Diagram (ERD)

**E. Logical Record Structure (LRS)**

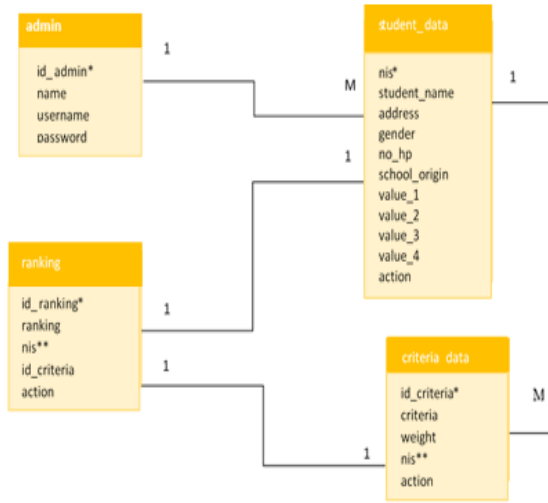


Figure 5. Logical Record Structure (LRS)

**F. User Interface**

**Login Page**



Figure 6. Login page

On this page the admin will login to the system.

**Prospective Student Data Page**

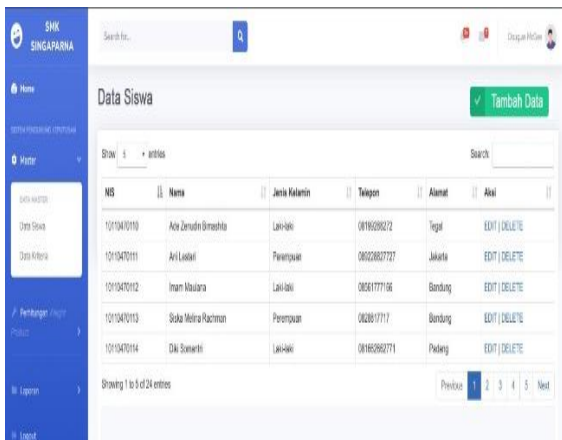


Figure 7. Prospective Student Data Page

This page serves to display the data of prospective students who have registered which will be used as an alternative in the calculation. On this

page the admin can also edit, delete and add prospective student data.

**Criteria Data Page**

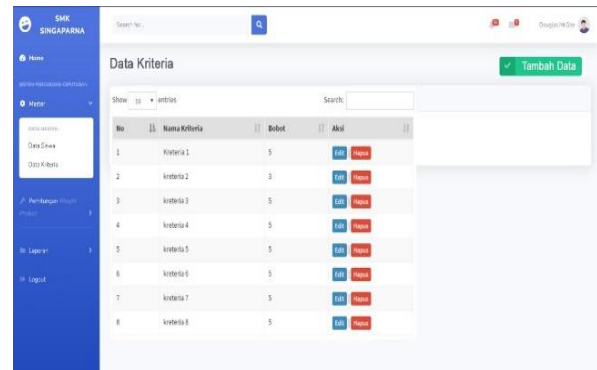


Figure 8. Criteria Data Page

This page serves to display the criteria data used in the calculation process. On this page the admin can also edit, delete and add criteria data.

**Product Weight Calculation Page**

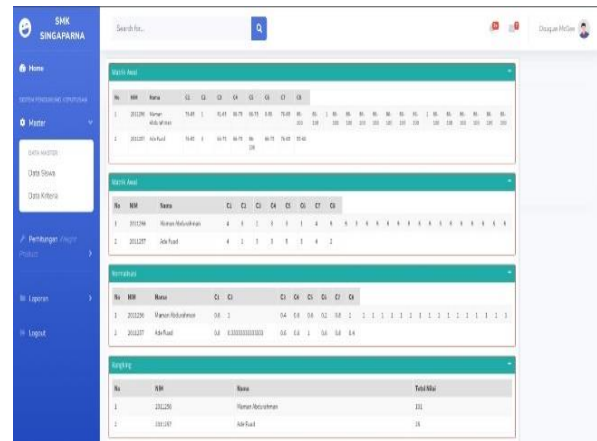


Figure 9. Weight Product Ranking Page

On this page the admin will perform the calculation process.

**Ranking Pages**

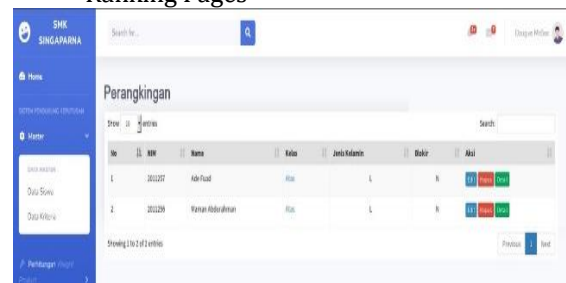


Figure 10. Weight Product Ranking Page

On this page will display the results of the calculation process that will be used as rankings and from the results of this ranking it can be seen who passed the selection and advanced to the next stage.

## CONCLUSION

From the results of calculations with 4 criteria, namely C1 Mathematics, C2 English, C3 Indonesian and C4 Tadarus which were applied to 4 alternative students from SMK Singaparna as a sample and based on the provisions of SMK Singaparna that students who were considered to have passed the selection were students who had more preference scores from 0.250. It can be seen that from the results of calculations that have been carried out there are 3 students who have passed the selection, while 1 student is declared not to have passed the selection.

With this system, it is hoped that the selection procedure for new student admissions can be more computerized and produce more precise and accurate information. The selection procedure for new admissions can be more structured with the criteria used for ranking. The existence of a desktop-based application makes it easier for admins in the ranking process for the selection of new student admissions.

For further system development, it is necessary to add criteria that will be used for ranking, in addition to adding other methods for comparison.

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## COMPARISON OF EIGENFACE AND FISHERFACE METHODS FOR FACE RECOGNITION

Elly Firasari<sup>1</sup>; F Lia Dwi Cahyanti<sup>2</sup>; Fajar Sarasati<sup>3</sup>; Widiastuti<sup>4</sup>

Information System<sup>1,2</sup>, Digital Business<sup>3,4</sup>

Nusa Mandiri University

[www.nusamandiri.ac.id](http://www.nusamandiri.ac.id)

[elly.efa@nusamandiri.ac.id](mailto:elly.efa@nusamandiri.ac.id)<sup>1</sup>; [flia.fdc@nusamandiri.ac.id](mailto:flia.fdc@nusamandiri.ac.id)<sup>3</sup>; [fajar.fss@nusamandiri.ac.id](mailto:fajar.fss@nusamandiri.ac.id)<sup>3</sup>;

[widiastuti.wtu@nusamandiri.ac.id](mailto:widiastuti.wtu@nusamandiri.ac.id)<sup>4</sup>

**ABSTRACT**— *Biometric information systems have been widely used in the fields of government, shopping centers, education and even security, which offer biological authentication so that the system can recognize its users more quickly. The parts of the human body are identified by a biometric system that has unique and specific characteristics, one of which is the face. Adjustment of facial image deals with objects that are never the same, due to the parts that can change. These changes are caused by facial expressions, light intensity, shooting angle, or changes in facial accessories. With this, the same object with several differences must be recognized as the same object. In this study, the data used were 388 face images and the sata test consisted of 30 face images. Before the face is tested, preprocessing and feature extraction are carried out using the Haar Cascade Classifier and then detected using Eigenface and Fisherface. Based on the research results, the Fisherface method is an algorithm that is accurate and efficient compared to the Eigenface algorithm. The Fisherface algorithm has an accuracy of 88%, while the Eigenface method has an accuracy rate of 76%.*

**Keywords** – *Haar Cascade Classifier, Eigenface, Fisherface.*

**Intisari**— Sistem informasi biometrik sudah banyak digunakan baik dalam bidang pemerintahan, pusat pembelanjaan, pendidikan bahkan keamanan yang menawarkan autentikasi secara biologis sehingga memungkinkan sistem dapat mengenali penggunaanya lebih cepat. Bagian tubuh manusia diidentifikasi oleh sistem biometrik yang memiliki sifat unik dan spesifik salah satunya adalah wajah. Pengenalan citra wajah berhubungan dengan objek yang tidak pernah sama, dikarenakan adanya bagian-bagian yang dapat berubah. Perubahan tersebut disebabkan oleh ekspresi wajah, intensitas cahaya, sudut pengambilan citra, atau perubahan aksesoris pada wajah. Dengan hal ini, objek yang sama

dengan beberapa perbedaan tersebut harus dikenali sebagai satu objek yang sama. Dalam Penelitian ini data yang digunakan sebanyak 388 citra sebagai data training dan 30 citra sebagai data testing. Citra wajah diuji dengan preprocessing dan ekstraksi fitur menggunakan *Haar Cascade Classifier* kemudian di deteksi menggunakan *Eigenface* dan *Fisherface*. Berdasarkan hasil penelitian Metode *Fisherface* merupakan metode yang akurat dan efisien dibandingkan dengan metode *Eigenface*. Metode *Fisherface* memiliki akurasi sebesar 88%. sedangkan metode *Eigenface* memiliki tingkat akurasi 76%.

**Kata Kunci:** *Haar Cascade Classifier, Eigenface, Fisherface,*

### INTRODUCTION

Advances in technology are currently driving the development of various information systems, one of which is a biometric information system. Biometric information systems have been widely used in the fields of government, shopping centers, education and even security that offer biological authentication so that the system can identify users more quickly. Parts of the human body are identified by a biometric system which has unique and specific characteristics, one of which is the face.

Face recognition is a pattern recognition approach for personal identification purposes in addition to other biometric approaches such as fingerprint recognition, signatures, eye retinas and etc (Kustian, 2017). In general, the way facial recognition works is by converting photos, sketches and video images into a series of numbers called faceprints and then comparing them with other series of numbers that represent familiar faces.

Face image recognition deals with objects that are never the same, because there are parts that can change. These changes are caused by facial expressions, light intensity, image capture angle, or changes in accessories on the face. In this case, the same object with several differences must be

recognized as the same object. Research conducted by Putranto, et al in 2016 on Face Recognition using Eigenface with naive Bayes shows that the proposed method can predict facial images up to 70%, moreover by adding a normalized Z-Score the prediction increases up to 89.5% (Putranto et al., 2017).

Research conducted by Supriyanto, Hasanah and Santoso on Real-Time Face Imaging Systems with Adabost, Eigenface PCA & MySQL gives a success rate of 80% (Supriyanto, 2013).

Research conducted by Phankokkrud and Jaturawat in 2019 concerning Influence of Facial Expression and Viewpoint Variations on Face recognition Accuracy by Different recognition Algorithm which aims to compare the Eigenfaces, Fisherfaces, and LBPH algorithms. In this study, the highest accuracy was obtained by LBPH which achieved an accuracy of 81.67% (Phankokkrud & Jaturawat, 2017).

Research conducted by Aditya, et al in 2020 concerning Face recognition System Implementation As a media Access to Restricted Room with Histogram Equalization and Fisherface Methods. Has a success rate of 88.33% obtained from 120 trials consisting of 12 poses (Aditya et al., 2019).

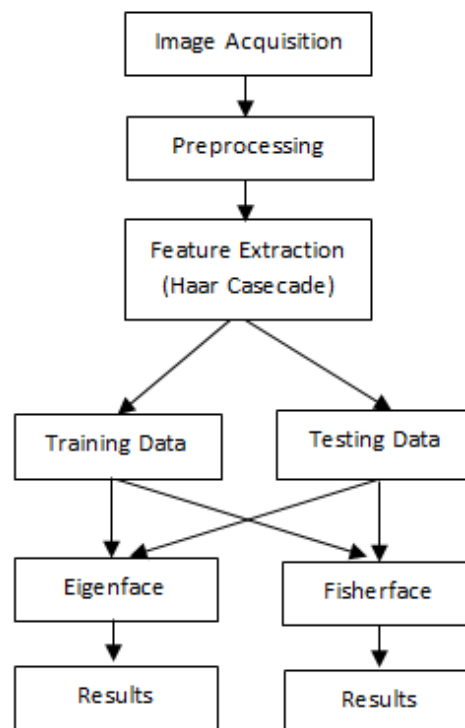
Research conducted by Rahman, et al on Face recognition in Low Lighting Conditions Using the Fisherface method and CLAHE Techniques, the system works well for facial recognition with brightness level performance and the system's facial recognition works well at a brightness level of 50% with an accuracy of 76.92% (Rahman, Sthevanie, and Ramadhani, 2020).

In this study, a facial recognition system was used using the Eigenface and Fisherface methods. The main idea of the eigenfaces method consists of extracting facial features and representing faces as linear combinations called "eigenfaces".

These eigenvectors are derived from the covariance matrix of the probability distribution of the high-dimensional vector space of all facial images in the database (Mantoro, Ayu, and Suhendi, 2018).

*Fisherface is one of the popular methods used in face recognition, and is widely believed to be superior to other techniques, such as eigenface because it attempts to maximize the separation between classes in the training process.* (Wahyuningsih et al., 2019).

## RESEARCH METHOD





**Figure 1. Research Method**

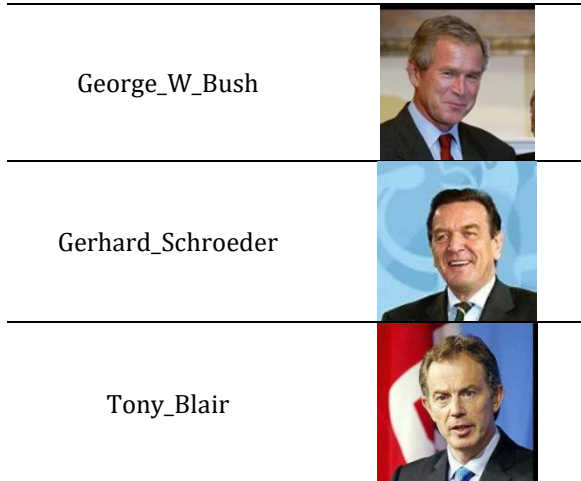
### A. Image Acquisition

Image acquisition can be interpreted as the process of capturing an image from an analog image to a digital image (Utama, 2011). The purpose of image acquisition is to determine the data that will later be used in a study (Fadjeri et al., 2020).

The dataset used by the authors comes from Kaggle regarding Face Recognition. Face Recognition data consists of training data and testing data. The training data consists of five classes with a total of 388 facial images and the testing data consists of 30 facial images

Table 1. Sample Face

Name	Dataset 1
Colin_Powell	
Donald_Rumsfeld	



**B. Preprocessing**

Preprocessing is a step taken for data processing to obtain accurate and consistent data (Kumar and Chandrasekhar, 2012). In the preprocessing process, the facial image is converted to a size of 100x100 pixels to make processing easier. Furthermore, the image is converted to grayscale or greyscale in order to simplify the image model.

**C. Ekstraksi Fitur Haar Cascade Classifier**

In this study, implementing the Haar Cascade Classifier to detect human faces using an Open Source Computer Vision Library called OpenCV. Originally, this method was provided by Paula Viola and Michael Jones (Viola and Jones, 2001). For human face detection, haar features are the main part of haar cascade classifier. The haar feature is used to detect the presence of features in a given image (Singh et al., 2013)

Feature extraction uses the Haar Cascade Classifier where the overall form of the detection process using the haar cascade is a form of degeneration of a decision tree called a cascade. A positive result from the first classifier triggers an evaluation of the second classifier which has also been adjusted to achieve a very high detection rate. A positive result from the second classifier triggers the third classifier and so on. A negative result at any point leads to an immediate rejection of the sub-window (Viola & Jones, 2001).



Figure 1. Sample Face Picture

- (a) Original Image
- (b) Converted to gray scale and then cropped for the detected facial area using the Haar-cascade Classifier

**D. Save the dataset to the database**

In this study there are 5 classes that allow for facial recognition. The image samples from each of these classes are extracted from the features into the Haar Cascade Classifier and then saved in the form of an xml file.

**E. Eigenface**

The basic idea of eigenfaces is that all face images are similar in all configurations and can be described in terms of the base face image. Based on this idea, the eigenfaces procedure is as follows (Kshirsagar et al., 2011).

- a) assumes the set of training images is  $\Gamma_1, \Gamma_2, \dots, \Gamma_m$  with each image is  $I(x, y)$ . Convert each image to a new set of vectors and full size matrices ( $m \times p$ ), where  $m$  is the number of training images and  $p$  is  $x \times y$ .
- b) Find the average face with :

$$\Psi = \frac{1}{m} \sum_{i=1}^m \Gamma_i \dots \dots \dots (1)$$

- c) Calculate the face minus the average:

$$\Phi_i = \Gamma_i - \Psi, I = 1, 2, \dots, m \dots \dots \dots (2)$$

$A = [\Phi_1, \Phi_2, \dots, \Phi_m]$  is the matrix vector minus the mean and size  $A_{mp}$ .

- d) By applying matrix transformation, the vector matrix is reduced by:

$$C_{mp} = A_{mp} \times A_{pm}^T \dots \dots \dots (3)$$

where  $C$  is the covariance matrix and  $T$  is the transpose matrix

- e) Determine the eigenvectors,  $V_{mm}$  and eigenvalues,  $\lambda_m$  from the matrix  $C$  use the Jacobi method and construct the eigenvectors with the highest eigenvalues. The Jacobi method was chosen because of its accuracy and reliability compared to other methods.

- f) Apply the eigenvector matrix,  $V_{mm}$  and the adjusted matrix,  $\Phi_m$ . This vector defines a linear combination of the training set images to form eigenfaces :

$$U_k = \sum_{n=1}^m \Phi_n V_{kn}, k = 1, 2, \dots, m \dots \dots \dots (4)$$

- g) Based on eigenfaces, each image has a face vector by:

$$W_k = U_k^T(\Gamma - \Psi), k = 1, 2 \dots m \dots\dots\dots (5)$$

and the vector mean minus size (p × 1) and eigenfaces is U<sub>pm</sub>. the weights form the feature vector:

$$\Omega^T = w_1 w_2, \dots w_m \dots\dots\dots (6)$$

h) A face can be reconstructed using its features, vectors Ω<sup>T</sup> and the previous eigenfaces, U<sub>m</sub> ' as:

$$\Gamma = \Psi + \Phi_f \dots\dots\dots (7)$$

Where,

$$\Phi_f = \sum_{i=1}^m w_i U_i \dots\dots\dots (8)$$

**F. Fisherface**

Fisherface was developed to overcome the weakness of Eigenface (Mutiara & Prasetyo, 2019). Fisherfaces (Phankokkruad & Jaturawat, 2017) is a strong method with arguments in favor of using the linear method for dimension reduction in facial recognition problems at least when one is looking for insensitivity to lighting conditions. Since learning sets are labeled, it makes sense to use this information to build more reliable methods to reduce the dimensionality of the feature space.

Using class-specific linear methods for dimensionality reduction and simple classifiers in reduced feature space, one might get better recognition rates. However, the results of many studies reveal that both methods have effective processing time and storage usage. *Fisher's Linear Discriminant* (FLD) is an example of a class-specific method, in the sense that it tries to "shape" a spread to make it more reliable for classification. This method selects w so that the spread ratio between classes and the spread of the inner class is maximized. Let the scatter matrix between classes be defined as:

$$S_b = \sum_{j=1}^C \sum_{i=1}^{n_j} (x_{ij} - \mu_i)(x_{ij} - \mu_i)^T \dots\dots (9)$$

where x<sub>ij</sub> is the i<sup>th</sup> sample of class j, μ<sub>j</sub> is the mean of class j, and n<sub>j</sub> is the number of samples of class j. Likewise, 232 between class differences were calculated using the scatter matrix between classes,

$$S_b = \sum_{j=1}^C (\mu_j - \mu)(\mu_j - \mu)^T \dots\dots\dots (10)$$

where μ<sub>i</sub> is the average image of the class X<sub>i</sub>, and μ is the average image of all classes. N<sub>i</sub> is the number of image samples of class X<sub>i</sub>, and C is number of classes. S<sub>w</sub> is the maximized value of the inter-class scatter matrix whereas w is the minimized in-class scatter matrix for use in the classification process.

To illustrate the benefits of class-specific linear projections, construct a low-dimensional analogue for a classification problem in which the samples from each class lie in a close linear subspace.

**G. Face recognition**

Face recognition in this study calls the xml file from the training data and the xml file from the cascade classifier which is used to detect faces and eyes. The facial recognition process for the two methods analyzed is the same if the confidence value is higher than the threshold value, if the ID is equal to -1 then the face cannot be recognized.

**H. Accuracy**

Accuracy is a measure of the total system in classifying correctly, which means that objects are detected correctly and the background is not detected. Sensitivity is the percentage of the number of objects that are correctly detected (objects of interest) in the entire set of images that contain objects of interest. Meanwhile, specificity is the percentage of the number of objects other than faces (objects of interest) in the entire set of images where there are no objects of interest.

Equation (11) to Equation (13) shows the formula for calculating accuracy, sensitivity, and specificity parameters. True Positive (PB) can be analogous to the object being seen as a detected face. True Negative (TN), that is, objects other than faces (background) are not correctly detected as faces. False Positive (FP) is an object other than a face (background) detected as a face. False Negative (FN) is a face object that is not detected as a face (Hardiyanto & Anggun Sartika, 2018).

$$Precision = \frac{TP}{TP+FP} \dots\dots\dots (11)$$

$$Recall = \frac{TP}{TP+FN} \dots\dots\dots (12)$$

$$Akurasi = \frac{TP+TN}{TP+TN+FP+FN} \dots\dots\dots (13)$$

**RESULTS AND DISCUSSION**

**A. Eigenface Method Processing**

The following are the results of facial recognition testing using the Eigenface method.

Table 2. Confusion Matrix Eigenface Method

Colin_Powell	5	0	0	0	0
Donald_Rumsfeld	0	5	0	0	0
George_W_Bush	0	1	2	0	2
Gerhard_Schroeder	0	0	0	5	0
Tony_Blair	1	0	2	0	2
	Colin_Powell	Donald_Rumsfeld	George_W_Bush	Gerhard_Schroed	Tony_Blair

Based on the table above, we can see that Colin Powel can all be detected, George W Bush is detected in 4 images while 1 image is detected as Tony Blair as well as Donal Rumfeld, then 2 are detected as Donal Rumfeld 2 are detected as Tony Blair and Donal, Gerhard Schoeder is successfully detected all, then 2 detected as Tony Blair and 2 detected as George.

**B. Fisherface Method Processing**

The following are the results of facial recognition testing using the fisherface method

Table 3. Confussion Matrix Fisherface Method

Colin_Powell	5	0	0	0	0
Donald_Rumsfeld	0	5	0	0	0
George_W_Bush	0	0	4	0	1
Gerhard_Schroede r	0	0	0	4	0
Tony_Blair	0	0	1	1	3
	Colin_Powell	Donald_Rumsfeld	George_W_Bush	Gerhard_Schroed	Tony_Blair

In the table above we can see that Colin Powel can be detected all, as well as Donal Rumfeld, then 4 detected as Donal Rumfeld 1 detected as Tony Blair, George W Bush detected 4 images while 1 image detected as Tony blair. Gerhard Schoroed detected 4 images and 1 was detected as Tony Blair,

then 3 were detected as Tony Blair 1 was detected as George and 1 was detected as George.

**C. Comparison of Accuracy, Precision, and Recall of Eigenface and Fisherface**

The following is the result of a comparison of the Eigenface and Fasherface Methods

Table 4. Comparison of Accuracy, Precision, and Recall of Eigenface and Fisherface

Method	Precision	Recall	Accuracy
1. Eigenface	73%	76%	76%
2. Fisherface	88%	88%	88%

Based on the table above, we can see that the Fisherface method is superior to the Eigenface method. The Eigenface method is still difficult to recognize faces compared to the Fisherface method which can still recognize faces when there is a change in facial expressions

**CONCLUSION**

Based on research using face datasets grouped into five classes, processed using feature extraction of the Haar Cascade Classifier and processed using the Eigenface and Fisherface facial recognition methods, it can be concluded that the Fisherface method is an accurate and efficient method compared to the Eigenface method. The Fisherface method has an accuracy of 88%. while the Eigenface method has an accuracy rate of 76%.

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## MEAT IMAGE CLASSIFICATION USING DEEP LEARNING WITH RESNET152V2 ARCHITECTURE

Taopik Hidayat<sup>1</sup>; Faruq Aziz<sup>2</sup>; Daniati Uki Eka Saputri<sup>3\*</sup>

Sains Data<sup>1</sup>

Sistem Informasi<sup>2,3</sup>

Universitas Nusa Mandiri

<https://nusamandiri.ac.id/>

taopik.toi@nusamandiri.ac.id<sup>1</sup>, faruq.fqs@nusamandiri.ac.id<sup>2</sup>, daniati.due@nusamandiri.ac.id<sup>3\*</sup>



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**Abstract**— Meat is a food ingredient that can be consumed by humans and consists of essential nutrients, especially protein, which is needed for various physiological functions in the human body. Beef, mutton, and pork are meats commonly used by Indonesian people as daily processed foods. A very high level of meat consumption results in a high economic value of meat consumption. However, many people do not know how to distinguish between the types of beef, mutton, and pork. This study aims to classify beef, mutton, and pork types using the ResNet152V2 algorithm. The data used are 600 images with 200 images of beef, 200 images of mutton, and 200 images of pork. The process carried out is pre-processing using 4 stages, namely image augmentation, and image sharpness process, then the image is resized to adjust the size required by the algorithm. The last pre-processing is to perform the image normalization process. After the pre-processing is done, then the data training stage is carried out using the ResNet152V2 algorithm to build a classification model, and then the model is tested against data testing to obtain the optimal results of image classification of pork, mutton, and beef by looking at the result of accuracy and loss values.

**Keywords:** Classification, ResNet152V2, Red Meat

**Intisari**— Daging merupakan bahan makanan yang dapat dikonsumsi oleh manusia dan terdiri dari zat gizi esensial, terutama protein, yang diperlukan untuk berbagai fungsi fisiologis dalam tubuh manusia. Daging sapi, kambing, dan babi merupakan daging yang biasa digunakan masyarakat Indonesia sebagai makanan olahan sehari-hari. Tingkat konsumsi daging yang sangat tinggi mengakibatkan nilai ekonomi konsumsi

daging juga tinggi. Namun banyak orang tidak mengetahui cara membedakan antara jenis daging sapi, kambing, dan babi. Penelitian ini bertujuan untuk mengklasifikasikan jenis daging sapi, kambing dan babi menggunakan algoritma ResNet152V2. Data yang digunakan sebanyak 600 citra dengan 200 citra adalah daging sapi, 200 citra daging kambing dan 200 citra daging babi. Proses yang dilakukan adalah pra-pemrosesan menggunakan 4 tahapan yaitu augmentasi citra, proses sharpness citra, kemudian citra dilakukan proses resize untuk menyesuaikan ukuran yang dibutuhkan algoritma. Pra-pemrosesan terakhir adalah melakukan proses normalisasi citra. Setelah pra-pemrosesan dilakukan kemudian dilakukan tahap training data menggunakan algoritma ResNet152V2 untuk membangun model klasifikasi dan kemudian model tersebut diujikan terhadap data testing untuk mendapatkan hasil klasifikasi citra daging babi, kambing dan sapi secara optimal dengan melihat hasil akurasi dan nilai loss.

**Kata Kunci:** Klasifikasi, ResNet152V2, Daging Mentah

### INTRODUCTION

Meat is a food ingredient that can be consumed by humans and consists of essential nutrients, especially protein, which is needed for various physiological functions in the human body (Susanti et al., 2022). Therefore, without a doubt, meat is not only an important food for human beings but also an important part of human life. Based on data obtained from the Directorate General of Livestock and Animal

Health (Ditjen PKH) there were 4.9 million tonnes consisting of buffalo, beef, mutton, chicken, pork, and other meat consumed in 2019 (RI, 2020).

Pork, mutton, and beef are meats commonly used by Indonesian people as processed foods. Based on a survey of the Basic Needs Market Monitoring System (SP2KP), per capita meat consumption in Indonesia reaches 6.4 kg of beef, 12.2 kg of pork, and 1.7 kg of mutton per capita per year. A very high level of meat consumption results in a high economic value of meat consumption.

The beef, mutton, and pork types look like the same meat. However, the three types of meat have different characteristics and meat colors. Beef has a distinctive dark red color, is thick, and has a distinctive smell. Mutton meat has a characteristic dark red, sometimes pink and bright color and a pungent fishy odor (Maghiszha, 2020). While the physical characteristics of pork are red but rather pale, soft in texture, and have a fishy smell.

Many people do not know how to distinguish between the types of beef, mutton, and pork. This often results in fraudulent practices by mixing pork which is cheaper than beef (Delfana et al., 2020). People find it difficult to distinguish pork from other meats. The community became uneasy with this cheating, considering that pork is a food that is prohibited for consumption, especially by Muslims.

The use of computer technology is now widely applied in various sectors of life, one of which is in the field of Artificial Intelligence (AI). AI can learn like humans by using algorithms that contain mathematical laws and is capable of doing jobs such as diagnosing diseases, predicting opportunities, and classifying objects (Maulana & Rochmawati, 2020). The scope of AI science that is capable of classifying an object/image is deep learning with image processing.

Image processing is able to classify and recognize images quickly and efficiently against large amounts of data. One of the image-processing algorithms is the Convolutional Neural Network (CNN) (Maulana & Rochmawati, 2020). CNN is an algorithm developed from the multilayer perceptron (MLP) which is designed to process two-dimensional data (Yuliani et al., 2019). Several previous studies have been carried out to differentiate meat images by utilizing the CNN algorithm with various other modifications (Ayaz et al., 2020), (Imam et al., 2021), (Yudamson et al., 2020).

Image processing for the classification of meat has been done by several researchers before. Other studies have succeeded in

classifying beef, mutton, and pork. In research conducted by Alhafis (2020) using the Convolutional Neural Network method, the EfficientNet-B0 architecture for the classification of types of beef, mutton, and mixed meat. the research succeeded in classifying meat images (Alhafis et al., 2022).

However, this research cannot improve accuracy, so this research will try to use the augmentation method and several other processes so that the machine can recognize images better so as to be able to optimize the results of image classification.

Another research was conducted by Agustin (2020) and Calvin (2020) regarding the identification of chicken meat images. In Agustin's research, free-range and broiler chickens were used with the aim of classifying freshness using the GLCM method and texture extraction of the Gray Level Co-Occurance Matrix using the K-Nearest Neighbors method (Feri Agustina, 2020).

Same with Calvin's research, namely using chicken meat, to build a classification model with the K-(KNN) method (Surudin et al., 2020). Another study was conducted by Titin (2021) using the K-Nearest Neighbor (KNN) method by carrying out a feature selection process using the F-Score to select relevant features and eliminate irrelevant features in classifying the freshness level of beef (Yulianti et al., 2021). The third study used a classification technique to obtain the results of the image classification of chicken meat. So this research will try to use a more varied type of meat to classify images using the CNN method.

Based on several studies that have been carried out, this study aims to carry out a classification process for the image of red meat of several types, namely red meat consumption of local types, namely pork, mutton, and beef using the classification method. The dataset was taken using a digital camera according to the type of meat in pieces with a distance of 10 cm. The method used is a Convolutional Neural Network (CNN) using the ResNet152V2 architecture.

Image augments reproduce images so that the machine can carry out various learning processes to recognize different forms of images. After augmentation, the meat image is sharpened (sharpness) and then resized and normalized to get good classification results for beef, mutton, and pork images.



## MATERIALS AND METHODS

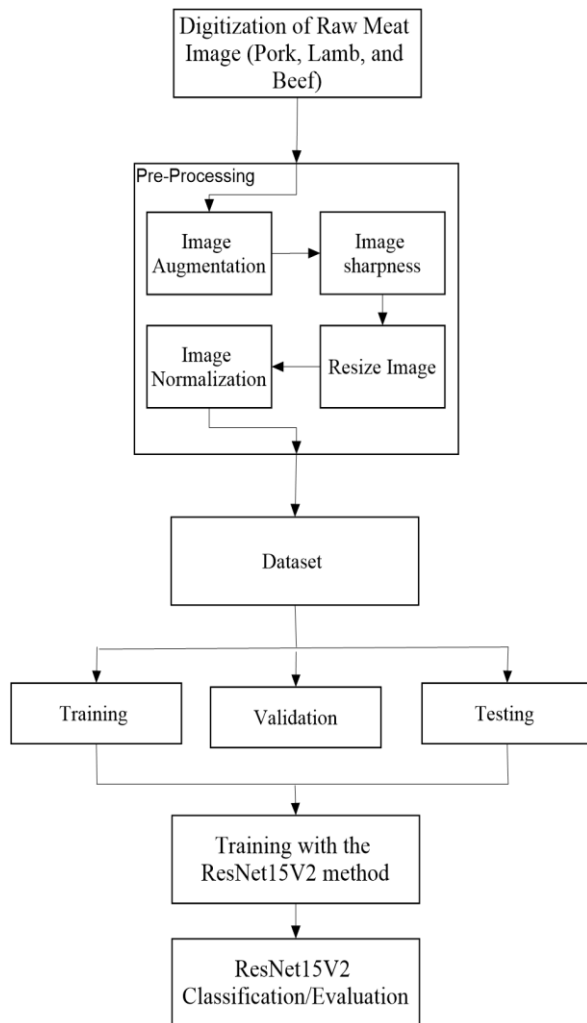


Figure 1. Research Methodology

### 1. Image Digitization

Image digitization is carried out by taking research objects to become dataset material by converting them into digital image forms using a digital camera. The object of this research is red meat which consists of three types, namely pork, mutton, and beef which are widely sold in local Indonesian markets.

### 2. Image Pre-processing

After the red meat image digitization process is carried out, then proceed with the image pre-processing process, the process is carried out in 4 stages, namely the image augmentation process or multiplying the image, followed by the sharpness process so that the image has better image quality, then the image is resized according to the process. with the size required by the algorithm and the last is to perform the image normalization process.

### 3. Dataset

A total of 600 images were successfully collected from the image digitization process using a camera, the images were taken at a distance of 10 cm. Image consists of types of pork, mutton, and beef. 200 images of beef were taken, 200 images of mutton, and 200 images of pork. The entire image will be processed to the next stage and divided into training data, validation data, and testing data.

### 4. Training Process

This study implements the deep learning method with the ResNet152V2 classification algorithm for red meat images. After the four pre-processing stages have been completed, then the red meat image is divided into training data/training data, validation data, and test data/testing data. The images used for the training process are 585 images that have been augmented. The augmented training data is then taken as much as 30% to become validation data. Furthermore, as many as 15 original images of meat were used for data testing, where the 15 images consisted of 5 images of pork, 5 images of mutton, and 5 images of beef.

### 5. Classification/Evaluation Process

The image classification process was carried out using the ResNet152V2 algorithm for three types of red meat to obtain the optimal classification accuracy value. After the training phase is completed, then a testing process is carried out to find out the results of the accuracy of the model built, whether it can carry out image classification properly, and find out how accurate the prediction of the type of red meat.

## RESULTS AND DISCUSSION

### 1. Digitizing the Image of Red Meat

The first stage in the image digitization process is to carry out the initial acquisition process, namely, image digitization or taking digital versions of objects in image format using a 20.1 megapixel Canon PowerShot G7X Mark II digital camera with a distance of 10 cm. Objects are placed on a pedestal for the shooting process to be carried out based on their respective types. This determination is made to facilitate image processing because the image taken is in accordance with what is desired.

Each image can be seen in Figure 2 below.

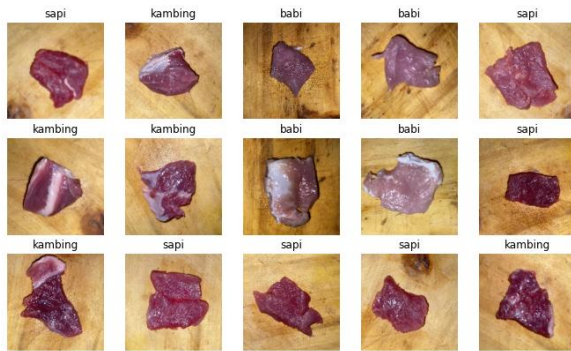


Figure 2. Red Meat Image Dataset

Figure 2 is an example of red meat images consisting of types of pork, mutton, and beef where the three have several differences in color and texture when taken with the same size and lighting. Pork has a paler color when compared to beef and mutton.

**2. Image Augmentation**

In the image augmentation process, it was used to multiply the images which were then used for training data, as many as 585 consisting of 195 pork images, 195 mutton images, and 195 beef images were augmented and produced 1746 images.

The augmentation process is carried out using the Flip technique (horizontal and vertical), Rotation of 90°, and exposure of the image by giving the light to make it brighter and reducing the light to make it darker where the brightness and darkness are 10%. The augmentation process is carried out so that the machine can carry out more of the learning process, namely recognizing various different forms of images from different sides.

Flip



Figure 3. Image Augmentation Results with the Flip Technique

Figure 3 shows meat image processing using the flip technique, the flip process increases the number of images by rotating the image position vertically and horizontally so that different versions of the image are obtained.

90° Rotate

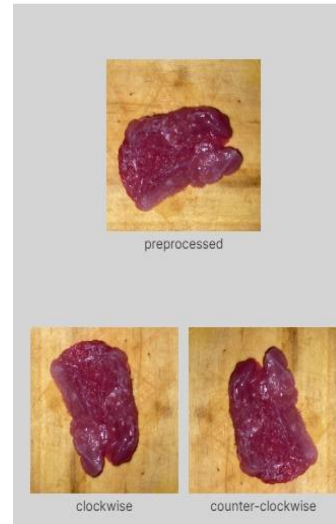


Figure 4. Image Augmentation Results with Rotation Techniques

Figure 4 is the result of meat image processing with a 90 degree rotation technique. By rotating it 90 degrees, the image has different display versions.

Exposure

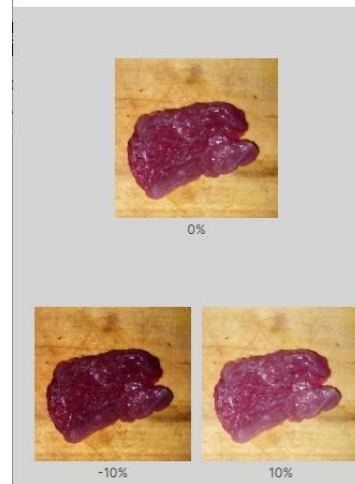


Figure 5. Image Augmentation Results with Exposure Techniques

Figure 5 is the result of meat image processing with an exposure technique of 10%. The exposure results show that the image appears brighter toward a positive number and appears darker toward a negative number. With this process, increasing the number of images used for the training process.

### 3. Image Sharpness

After the image augmentation process is carried out, the next step is to carry out the image sharpening process with the sharpness technique where the original images of beef, mutton, and pork that have noise or are blurry are sharpened so that the image looks clearer.

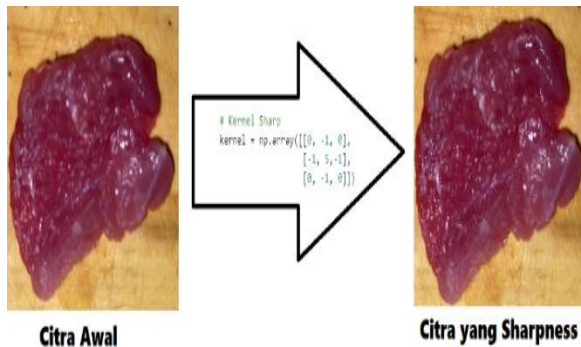


Figure 6. Meat Image Sharpness Results

Figure 6 is the image of the meat before and after the sharpness process. It can be seen that the image on the right has a sharper color after the sharpness process.

### 4. Resize Image

The resize process is used to reduce or enlarge the size of an image according to the desired size, it is intended that during the machine learning process it occurs faster and reduces memory usage so that image processing becomes more optimal (Asmara et al., 2017) (Yudamson et al., 2020).

The image resizing process is carried out using the Photoshop application by making the pixel size the same between images. The resizing process is carried out because the original size of the image is too large, so it is necessary to make the image size have the same dimensions, namely 224x224 pixels with a density of 72 dpi to match the method to be used.

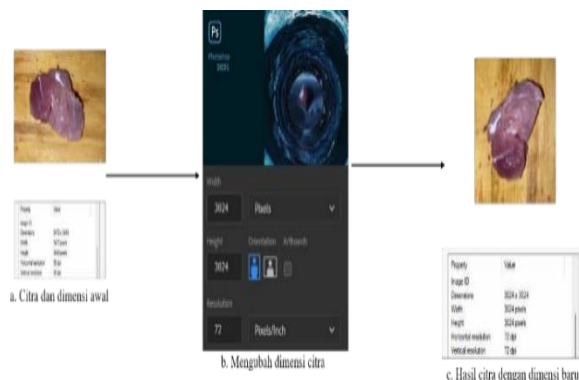


Figure 7. Meat image resizing process

Figure 7 is the flow of the resizing process, where the left image is the original image of red meat which is then converted into a new image with new dimensions of 224x224 pixels with a density of 72 dpi.

### 5. Image Normalization

Images that have been resized will produce a certain size with the dimensions of each image fixed and the same. The normalization process here is used so that the resolution of the resized image can be reduced so that during the machine learning process it is better and the resulting accuracy is optimal.

### 6. Dataset

The collection of images resulting from image digitization that can be used in the classification process is divided into 3 types, namely training data, validation data and testing data.

#### A. Training Data

A total of 1746 augmentation images were taken by 70% used for training data, the number of training images was 1222.

#### B. Validation Data

Validation data is data used as comparison data with training data (training data). The function of data validation is as the accuracy of the model obtained from training data (training data) (Breck et al., 2019). The validation data consists of 524 images or 30% of the total augmented images. The set of images from the validation data is different from the training data.

The image on the validation data is used to validate the built training model. After the training data and validation data carry out the training process and produce accuracy, then the model is stored in a file that stores the results of the machine learning.

#### C. Testing Data

A total of 15 images are stored in the test data set. The image contained in the testing data is different from the image contained in the training data and data validation. The testing image used is the original image without any processing. Images in data testing also have different representations.

**7. Training Data with the ResNet152V2 Method**

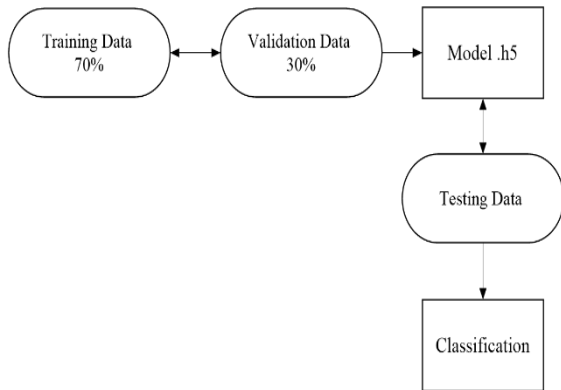


Figure 8. Illustration of the image training process

Figure 8 is an illustration of the meat image classification process. Starting with the training process on 70% of the data from a total of 1222 images of augmented meat at the pre-processing stage. The training process is carried out using the ResNet152V2 algorithm. Validation data is used to validate or ensure whether the model is appropriate and able to prevent overfitting, the number of images used for validation is 524 images, or 30% of the total training data. Then the training and validation results are stored in the .h5 model, where the file is a machine-learning model that will be used during the testing process. The testing process produces a red meat image classification model.

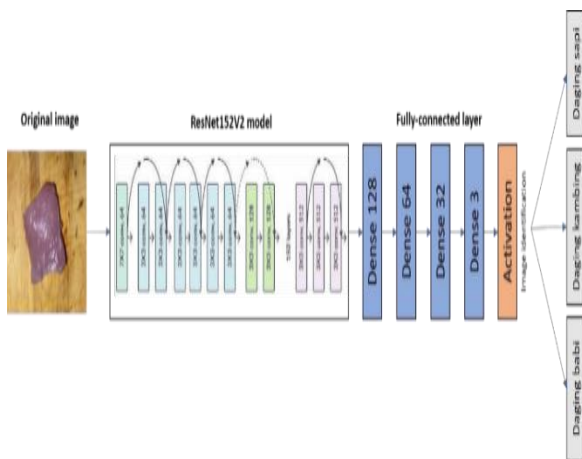


Figure 9. Illustration of the ResNet152V2 Architecture

Figure 9 is an illustration of the architecture built on by the ResNet152V2 algorithm. The model describes the stages performed by the algorithm, starting from image input, then the model performs a machine learning process based on the input provided. The algorithm uses a CNN network consisting of a

pooling/subsampling layer, a fully-connected layer, and a convolution layer (Ložnjak et al., 2020). Illustration of the ResNet152V2 architecture begins with the process of determining the hidden layer using trial and error with 3 hidden layers. Then it is continued by producing 128, 64, and 32 neurons. By using 2 types of activation functions to obtain output from each layer.

After determining the activation function then select the optimizer to determine the weight. The optimizer used in this study is the adam optimizer with a learning rate of 0.01, a batch size of 128, and an epoch of 100. This model accelerates the machine training process, where the input image will be processed and inserted into the convolution layer. In the next stage, the image will be labeled, namely the type of beef with label 2, mutton with label 1 and pork with label 0.

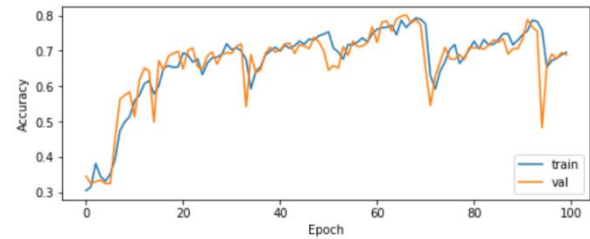


Figure 10. ResNet152V2 Architecture Training Accuracy Graph

Figure 10 is an accuracy graph generated during the training process with the ResNet152V2 architecture. It can be seen that the accuracy results increase when using high epochs. The training accuracy value shows the number 0.6956 and the accuracy value in the validation data is 0.6889. It can be seen that the graph of the accuracy value of the training data with the blue line and the validation data with the orange line shows comparable results increasing upwards, meaning that the accuracy of the training data is quite good for the image classification process.

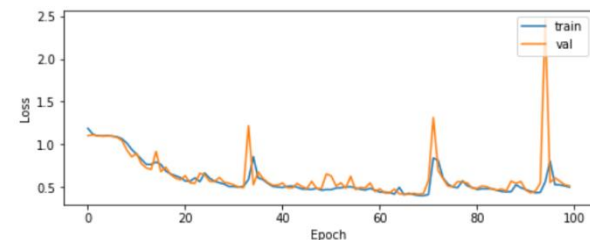


Figure 11. ResNet152V2 Architecture Loss Training Graph

Figure 11 is the result of loss or error in the image classification process produced during the

training process with the ResNet152V2 architecture. The loss value generated from the training data is 0.4974 and the loss value in the validation data is 0.5118. It can be seen that the loss value gets smaller when the epoch is higher, and the loss value from the training data with the blue line and the validation data with the orange line is directly proportional when it decreases.

### 8. ResNet152V2 Classification/Evaluation

The model generated from the machine learning process on pork, mutton, and beef training data is used to evaluate the results of meat image classification. The evaluation results can be used to find out how optimal the ResNet152V2 algorithm is in classifying red meat images.

The machine learning model resulting from the training process is then tested at this stage. The .h5 model was tested and produced accuracy and loss values. The test is carried out by adding a batch size parameter of 64.

The confusion matrix resulting from the learning model testing process is shown in Figure 12. The confusion matrix shows the results of measuring classification performance with results in the form of two or more classes where there are 4 terms, namely true positive (TP), true negative (TN), false positive (FP), and false negatives (FN) (Sarang Narkhede, 2018) (Mohajon, 2020). It can be seen that the y-axis is the predictive label of the model and the x-axis is the actual label of the red meat image.

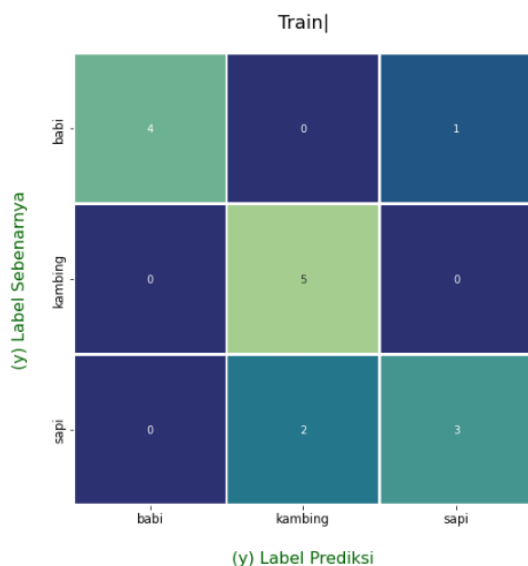


Figure 12. Image Classification Confusion Matrix

Based on Figure 12 it is known that each class has 5 images as test data. The results of the test based on the label can be concluded that 12 images were successfully identified and 3 images

failed to be identified with the following information:

- Prediction of pork images according to the class as many as 4 images and 1 image failed to be identified. Based on the results of the classification report, it can be concluded that a recall value of 0.80 means that 80% of the pork image is identified.
- Prediction of 5 images of mutton meat according to the class. Based on the results of the classification report, it can be concluded that a recall value of 1.00 means that the image of pork is 100% identified.
- Prediction of beef images according to the class as many as 3 images and 2 images failed to be identified. Based on the results of the classification report, it can be concluded that a recall value of 0.60 means that 60% of the pork image is identified.

Precision=

$$\frac{\text{The image of meat A is correctly identified}}{\text{The image of meat A is correctly identified} + \text{the image of meat X is identified as A}} \quad (1)$$

$$1. \text{ Precision Pork} = \frac{4}{4+0+0} = \frac{4}{4} = 1 \quad (2)$$

$$2. \text{ Precision Mutton} = \frac{5}{0+5+2} = \frac{5}{7} = 0,71 \quad (3)$$

$$3. \text{ Precision Beef} = \frac{3}{1+0+3} = \frac{3}{4} = 0,75 \quad (4)$$

From the precision calculations performed for each class, it can be concluded that the model obtained can identify well with the accuracy level of the model obtained to identify pork 1 images, the accuracy level for mutton image identification is 0.71, and the accuracy level for image identification beef 0.75. The model obtained can be concluded as a good model because it has a good precision value. If it is concluded again from the three comparisons above, it will produce an average precision value of 0.82.

$$F1\text{-score} = 2x \frac{\text{Precision value} \times \text{recall value}}{\text{precision value} + \text{recall value}} \quad (5)$$

$$1. F1\text{-score Pork} = 2\left(\frac{1 \times 0,80}{1 + 0,80}\right) = 2\left(\frac{0,80}{1,80}\right) = 0,89 \quad (6)$$

$$2. F1\text{-score Mutton} = 2\left(\frac{0,71 \times 1}{0,71 + 1}\right) = 2\left(\frac{0,71}{1,71}\right) = 0,83 \quad (7)$$

$$3. F1\text{-score Beef} = 2\left(\frac{0,75 \times 0,60}{0,75 + 0,60}\right) = 2\left(\frac{0,45}{1,35}\right) = 0,67 \quad (8)$$

From the f1-score calculations performed for each class, it can be concluded that the model

obtained has an average ratio of precision and recall of 0.89 for pork images, and an average comparison of precision and recall of 0.83 for mutton images. and the average comparison of precision and recall is 0.67 for beef images. If it is concluded again from the three comparisons above, it will produce an average comparison value of 0.80.


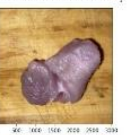



The results of testing or testing with the ResNet152V2 model on 15 images produce good accuracy values and loss values with the following calculations:


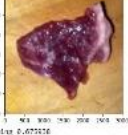
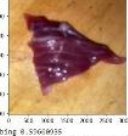






$$\text{Accuracy} = \frac{12}{15} = 0,8 = 80\% \quad (9)$$

$$\text{Loss} = \frac{6}{15} = 0,4 \quad (10)$$

From the calculation above, the resulting accuracy and loss is equal to 80% and a loss of 0.4. Classification results based on the results above, the ResNet152V2 classification model that has been built in the training process is then tested against the testing image. The following shows the results of image testing in table 1.

Table 1. Image test results

No	Image	Real Image	Prediction
1		Pork	Beef (0,46)
2		Pork	Pork (0,97)
3		Pork	Pork (0,98)
4		Pork	Pork (0,98)
5		Pork	Pork (0,99)

6		Mutton	Mutton (0,75)
7		Mutton	Mutton (0,67)
8		Mutton	Mutton (0,59)
9		Mutton	Mutton (0,63)
10		Mutton	Mutton (0,54)
11		Beef	Mutton (0,70)
12		Beef	Beef (0,53)
13		Beef	Beef (0,57)
14		Beef	Beef (0,58)

15		Beef	Mutton (0,62)
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Table 1 is the result of testing the image of the model that was built during the training process. Table 1 shows that there are 4 columns where the second column is the original image used for testing as many as 15 images. In the third column are the actual image names, pork, mutton, and beef. In the fourth column is the predicted value given by the machine resulting from the classification process of the ResNet152V2 method. The predicted value is very influential in determining the results of the classification of meat images.

In the 5 pork images, it can be seen that 1 image is predicted as beef with an accuracy value of 0.46. In the mutton image, it can be seen that all images are predicted as mutton images, in other words, 100% of mutton images are correctly predicted. Then in the beef image, it can be seen that as many as 2 images are predicted as mutton images.

### CONCLUSION

Based on the results of the above research, the red meat image classification process using the ResNet152V2 method was carried out by making a machine learning classification model for 585 images resulting in a classification accuracy value of 80% with an error value of 0.51. The accuracy value increases after several trials by increasing the epoch value and several pre-processing processes such as image augmentation, image sharpness, image resizing, and image normalization processes. Image testing with the model that has been built is able to classify images of pork, mutton, and beef according to the labels given. The classification results are greatly influenced by the color of the meat image and this study still uses three types of red meat, namely pork, mutton, and beef, so that in future research it can be developed again by adding the number of other red meat classes. In addition, in terms of methods, you can try other algorithms to compare better accuracy values and need to experiment with several other pre-processing so that the images are really good for machine processing to produce optimal accuracy values.

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## IMPLEMENTATION OF THE RIJNDAEL ALGORITHM ON WEB-BASED WHISTLEBLOWING SYSTEM

Abdul Latif<sup>1\*</sup>; Ai Ilah Warnilah<sup>2</sup>; Siti Khotimatul Wildah<sup>3</sup>

Sistem Informasi Kampus Kota Pontianak<sup>1</sup>  
Universitas Bina Sarana Informatika  
[www.bsi.ac.id](http://www.bsi.ac.id)  
[abdul.bll@bsi.ac.id\\*](mailto:abdul.bll@bsi.ac.id)

Sistem Informasi Kampus Kota Tasikmalaya<sup>2</sup>  
Universitas Bina Sarana Informatika  
[www.bsi.ac.id](http://www.bsi.ac.id)  
[ai.aiw@bsi.ac.id](mailto:ai.aiw@bsi.ac.id)

Teknologi Komputer<sup>3</sup>  
Universitas Bina Sarana Informatika  
[www.bsi.ac.id](http://www.bsi.ac.id)  
[siti.ska@bsi.ac.id](mailto:siti.ska@bsi.ac.id)



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**Abstract**— *In carrying out its responsibilities, an employee works for an agency or company and also works with his colleagues, whether they are co-workers or their own superiors. So it is very important for an employee to gain trust in his work environment. If there is a violation or behavior that deviates from an employee in the work environment, then there must be someone who reports it but of course by protecting the identity of the reporter. Based on these problems, the authors make and design a web-based whistle blowing application to protect the identity of people who report violations that occur in their work environment. This whistle blowing web is created using cryptographic algorithm methods. Cryptographic algorithms work by disguising data or information into a form of password that has no meaning. The author uses the Rijndael algorithm to encrypt the complainant's data. So that by using the Rijndael algorithm on this web-based Whistleblowing system, the data or reporting information will be safe in the database and it is hoped that an optimal system will be created for data and information security.*

**Keywords:** Whistleblowing System, Cryptographic Algorithm Method, Web Engineering, Rijndael.

**Intisari**— *Dalam melaksanakan tanggung jawabnya, seorang karyawan bekerja kepada sebuah instansi atau perusahaan dan juga bekerja dengan rekannya, baik itu rekan kerja maupun atasannya sendiri. Maka sangat penting bagi seorang karyawan untuk mendapatkan kepercayaan di lingkungan kerjanya. Apabila terjadi pelanggaran atau perilaku yang menyimpang dari seorang karyawan di lingkungan kerja, maka harus ada yang melaporkan hal tersebut namun tentunya dengan melindungi identitas pelapor itu. Berdasarkan permasalahan tersebut, penulis membuat dan merancang aplikasi whistleblowing berbasis web untuk melindungi identitas orang yang melaporkan pelanggaran yang terjadi di lingkungan kerjanya. Web whistleblowing ini dibuat dengan menggunakan metode algoritma kriptografi. Algoritma kriptografi bekerja dengan cara menyamarkan data atau informasi menjadi bentuk sandi yang tidak mempunyai makna. Penulis menggunakan algoritma Rijndael dalam mengenkripsi data pelapor. Sehingga, dengan menggunakan algoritma Rijndael dalam Whistleblowing sistem berbasis web ini, maka data pelapor atau informasi akan aman pada basis data dan diharapkan akan terciptanya sebuah sistem yang optimal untuk pengamanan data dan informasi.*

**Kata Kunci:** Whistleblowing System, Metode Algoritma Kriptografi, Web Engineering, Rijndael.

## INTRODUCTION

In carrying out his responsibilities, an employee does not only work for the benefit of the company or agency, but also for the benefit of other parties, be it superiors, colleagues, or other parties. Sometimes, employees in the company, superiors, or the company itself do not carry out their responsibilities properly.

One way to reveal violations or deviant behavior committed by employees, superiors, or the company itself is by whistleblowing. Whistleblowing is a complex process involving personal and organizational factors. According to Komite Nasional Kebijakan Governance (KNKG) or National Committee on Governance Policy in Yusar Sagara's research (Sagara, 2018), whistleblowing is the disclosure of violations or unlawful, unethical/immoral acts or other actions that can harm the organization or stakeholders, which are carried out by employees or organizational leaders to the leadership of the organization or other institutions that can take action for the violation. Meanwhile, someone who does whistleblowing is called a whistleblower. Every employee who reports a violation of deviant behavior by other employees, superiors, or even the company, does not want their identity to be known by anyone. When an employee becomes aware of a fraud, he or she can report the fraud to his employer when he is confident that his employer can eradicate the fraud (Tyas & Utami, 2020). To maintain the confidentiality of the data or the identity of the reporter, a cryptographic algorithm is needed.

Cryptography is the study of mathematical methods related to information security aspects, including data confidentiality, data validity, data integrity, and data authentication (Santoso, 2021).

According to Fadma et al, there are 3 main criteria of cryptography which are also aspects of information security, including: confidentiality, data integrity, and authentication (Abella et al., 2022).

The cryptographic algorithm that will be used to solve the problem of identity security in a web-based whistleblowing system is using the Rijndael cryptography method.

The Rijndael or known as AES (Advanced Encryption Standard) is a cryptographic algorithm was designed by Vincent Rijmen and John Daemen from Belgium (Rizal et al., 2019). This algorithm came out as the winner in the cryptographic algorithm contest held by the United States government's NIST (National Institutes of Standards and Technology) on November 26, 2001. Rijndael's algorithm is known as the Advance Encryption Standard (AES) (Smid, 2021).

This algorithm can be used to secure the reporting data in the database. With this algorithm,

it is hoped that an optimal system will be created for securing data or the identity of the reporter and the information contained in the database.

By implementing the Rijndael algorithm cryptographic technique, the system can secure the identity of the reporter stored in the database. As well as being able to create an optimal system for securing the identity of the reporter and providing a sense of security to the reporter in reporting irregularities that occur.

Some of the literature related to the use of the Rijndael algorithm include research conducted by Fathurrahmad and Ester from AMIK Indonesia (Fathurrahmad & Ester, 2020) with the title "Development And Implementation Of The Rijndael Algorithm And Base-64 Advanced Encryption Standard (AES) For Website Data Security". The research goals included the development of Base64 and the algorithm modified by Rijndael. Integrating the Base64 and AES Rijndael algorithms into the proposed algorithm is known to result in greater data security, according to research done through the encryption and decryption process. If the efficiency indicates that the proposed algorithm can be used as an alternative to the Base64 algorithm. In implementation, the speed of the proposed algorithm is good, but this can be seen from the encryption process and description, and the resulting bits are not significantly affected.

Furthermore, research conducted by Rinmar Siringoringo (Siringoringo, 2020) entitled "Analisis dan Implementasi Algoritma Rijndael (AES) dan Kriptografi RSA pada Pengamanan File" shows that the use of cryptographic algorithms can secure file. This study aims to build a file security application using the Rijndael algorithm and RSA cryptography. As a result, the system built is capable of encrypting and decrypting selected files with a 128-bit algorithm key length. The results of this study obtained encryption and decryption systems for plaintext and symmetric keys (sessionkey) with a combination of the Rijndael and RSA algorithms. The result of plaintext encryption on the built system is in the form of a character code, while for session key encryption it is in the form of a number code.

Research conducted by Setevi Liana Setiadi (Setiadi, 2019) entitled Perancangan Keamanan Data menggunakan Rijndael 256 pada Sistem Pusat Data Klasis Gunung Kidul Berbasis Client Server aims to design security in the data center system, especially on congregation data and offering data on the website of GKJ (Gereja Kristen Jawa). The author uses the Rijndael algorithm in his research, because according to him, this algorithm is an algorithm that has a very good operating speed. The security system application was built using the Rijndael 256 algorithm which was applied to secure

congregational data and GKJ Klasis Gunung Kidul offering data and was very helpful in securing very important data, so that only certain people could access the data. Data can be stored on the database server in the form of ciphertext and can be displayed again through the decryption process in plaintext (original text).

Research conducted by Rizal (Rizal et al., 2019) entitled "Cryptographic Symmetry Analysis with AES Algorithm for Safeguarding Data at Government Agencies". This research produce a program that can encrypt and decrypt data using the AES algorithm to secure data at Government Agencies. AES algorithm has been successfully applied to encrypt files with various extensions such as .doc, .xls, .ppt, .pdf, .jpg, .png, .MP4 and .Mp3, and the plain text can be recovered just like the original file. Data protected by the AES encryption method will not be corrupted provided it does not include text addition or deletion, trimming, brightness addition, and other edits that may alter the encrypted data.

Furthermore, in Aditya Ahmad Pradypta research (Pradypta, 2022) entitled "Perancangan Aplikasi Data Security Dalam Melindungi Informasi Digital Menggunakan Teknik Algoritma Rijndael Berbasis Desktop", examines desktop-based digital information security to secure important data such as files with extensions doc, exe, mp3, swf, mp4, avi and others. the application of the rijndael algorithm to various file formats can be encrypted properly with the extension format (\*.encrypt), and can be decrypted back into the previous format.

Then in a previous study entitled "Penerapan Ilmu Kriptografi Dalam Mengamankan Suatu File Citra Digital Dengan Menggunakan Algoritma Base64 Dan Rijndel" by Abdul Haris (Haris, 2020). In this study, the author wants to apply the algorithm contained in cryptography to secure the image when it is stored or when it wants to be sent so that no information leaks occur and the confidentiality of the information in the image is maintained. This study shows that if image data is used in encryption with the Bas64 algorithm, it will produce a temporary cipher or cipher which will then be re-encrypted with the Rijndel algorithm (AES). The process of extracting or decrypting the image can be done using the Rijndel (AES) algorithm first, so that it produces a pre-chiper and continues decrypting with the Base64 algorithm, so that it produces an initial plain image. The encryption and decryption system in this study uses two algorithms, which use a double-encryption and double-decryption system which goes through two processes.

Then in a study entitled "Column Level Database Encryption Using the Rijndael Algorithm and Dynamic Keys in Learning Management

Systems" by Mursalat (Mursalat et al., 2022), which aims to see the possibility of a successful key guessing attack on the Learning Management System (LMS) database. By using the proposed method, it appears that the probability of success of the key guessing attack is smaller than using the previous method proposed by Francis Onodueze. The key used to encrypt passwords with the Rijndael method is a static key so that key guessing attacks can be carried out easily using the brute force method. To improve security against key guessing attacks, a dynamic key generation method is proposed using HMAC-DRBG. Based on the results of the performance and safety evaluation of the previously proposed and currently proposed methods, it can be concluded that the time complexity for running the two methods is the same.

In a study entitled "Implementation of a File Encryption Software 'Hyde' using RIJNDAEL Algorithm (AES)", Itunuoluwa Isewon (Isewon, 2022) explains that the research aims to provide solutions to data security problems, in which case an unauthorized user or attacker is the case, have access to their data and information during transmission across different platforms. In addition, users want to embed messages in files such as image shorthand and text ciphers. problem. The Hyde System is a tool that provides data integrity services for important or private files and documents. This provides an extra layer of security for sensitive documents. If the security of a computer system is breached, either physically or remotely, sophisticatedly encrypted files or texts prevent unauthorized access, thereby preventing further attacks. The future scope of this idea is to develop cryptographic tools that are integrated as a component or service in a computer operating system to provide a seamless user experience that allows users to easily take advantage of the service. service. Future development will work to provide a service that embeds options in the file object's context menu for plain text/file encryption or encrypted file decryption.

## MATERIALS AND METHODS

### A. Research Methods

Research methods and data collection techniques used in this study, including Observation, Interview, Literature Review, and Development Method using waterfall model.

In this research, the waterfall method is adopted as the development method by Rosa A.S and Shalahudin (A.s. & Shalahuddin, 2016). The stages of the waterfall model are described as follows:

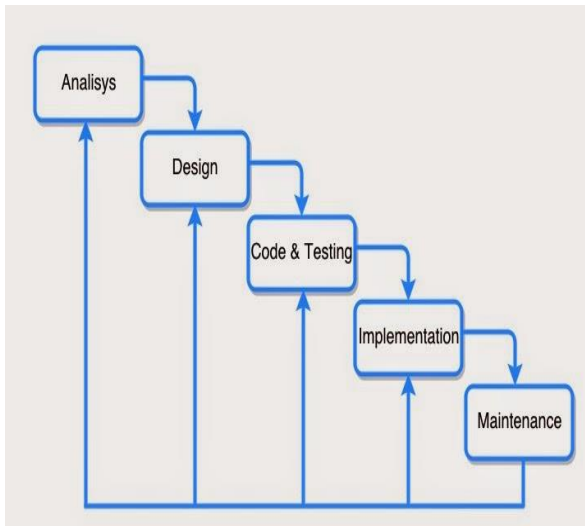


Figure 1. Waterfall Model

At the Analysis stage, the author collects all requirements related to hardware, software, user requirements, and system requirements. Then at the system design stage, the authors design diagrams, such as entity relationship diagrams (ERD) and Logical Relational Structure (LRS) diagrams. Furthermore, at the coding and testing stage, testing is carried out with blackbox testing which includes input and output processes, login form testing, form validation, and so on. At the implementation stage, the author uses a server that is hosted on a hosting provider and tested as a whole. Finally, at the maintenance stage, regular data backups are carried out. At this stage it is also possible to repeat the development process from specification analysis to changes to existing software, but not to create new systems.

The data source for this study is primary data from the data sources such as books and magazine articles. Methods of data collection are through observations, interviews, and literature searches. The data analysis used was qualitative.

## B. Rijndael Algorithm

AES Rijndael Algorithm recognizes 128-bit plain text and generates 128-bit length decrypted text using a secret key check using 128, 192, or 256 bits. It is an alternative permutation network design with a unique set of steps named rings (Pasuluri, 2021). A certain number of executions depends on the length of the AES algorithm key when implementing the algorithm.

Key length and block size can be selected independently. The flowchart below is the flow of data encryption using the Rijndael Algorithm:

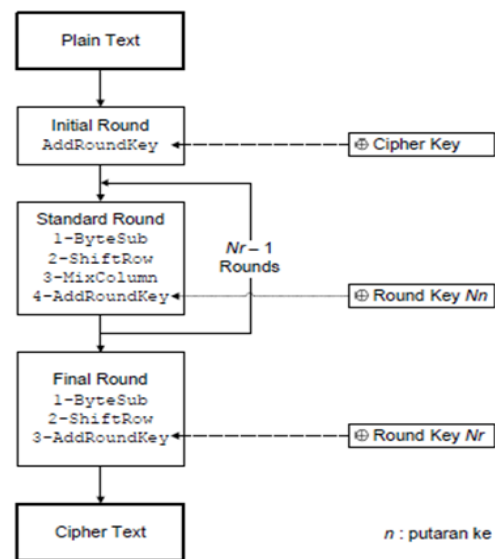


Figure 2. Rijndael Encryption Process Flowchart

Broadly speaking, AES encryption is described as follows. The input is an original 128-bit script, while the output is a random 128-bit script. Each transformation is performed directly on the script, starting with the AddRoundKey(0) transformation. So every transformation must have an inverse so that the random script can be decrypted. In rounds 1 to  $Nr - 1$ , SubBytes, ShiftRows, MixColumns and AddRoundKey transformations are performed on the text. In the last round ( $Nr$ ), the SubBytes, ShiftRows and AddRoundKey transformations are performed on the script (MixColumns transformation is not performed). In total there are  $Nr$  rounds. The number of turns ( $Nr$ ) depends on the size of the key used.

## RESULTS AND DISCUSSION

In creating a whistleblowing website that is integrated with the Rijndael algorithm, the authors analyze several needs such as hardware, software, user needs, system requirements, and system design.

In Waterfall Model, the discussion and research results are as follows:

### A. Requirement Gathering and Analysis

At this stage, the author collects all requirements related to hardware, software, user requirements, and system requirements. The author uses a Dell Server with a multi-core Intel® Xeon® Silver 4214 CPU 2.20GHz with 5GB RAM and 500GB SSD for hardware and software needs. Meanwhile, the operating system used is CloudLinux for the server.

Then for user needs, using a computer with an Intel Dual-core 2.0 Ghz Processor, 2 GB DDR2 RAM Memory, 250 GB Harddisk Memory, mouse, keyboard, monitor with a minimum screen resolution of 1024 x 768, as well as an internet connection with a minimum speed of 20 Mbps

Then for user needs, this website consists of 2 access rights, namely admin and user. Where, the user is the reporter, and the admin only has the right to verify the data without being able to change and see the identity of the reporter. For system requirements, the author uses MySQL for the database and PHP 7 for website creation, as well as the mcrypt module (MCRYPT\_ENCRYPT and MCRYPT\_DECRYPT) of type MCRYPT\_RIJNDAEL\_256 with Electronic Code Book (ECB) mode.

**B. System Design**

At the system design stage, the authors design diagrams, such as entity relationship diagrams (ERD), Logical Relational Structure (LRS) diagrams, and navigation structure.

In system design which aims to find out the functions that can be performed from the system created, including:

- ERD

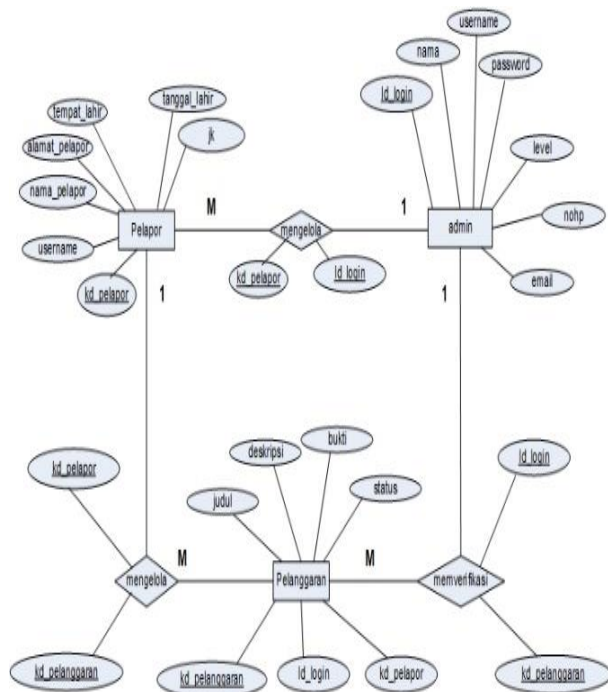


Figure 2. ERD Whistleblowing web-based Application

Figure 2 shows the relationship between the data store in the data relationship in this web-based whistleblowing application. In this application, there are 3 tables, namely admin, pelapor, and

pelanggaran. The relationship between tables or entities in the development of this whistleblowing web-based is described in Figure 2.

- LRS

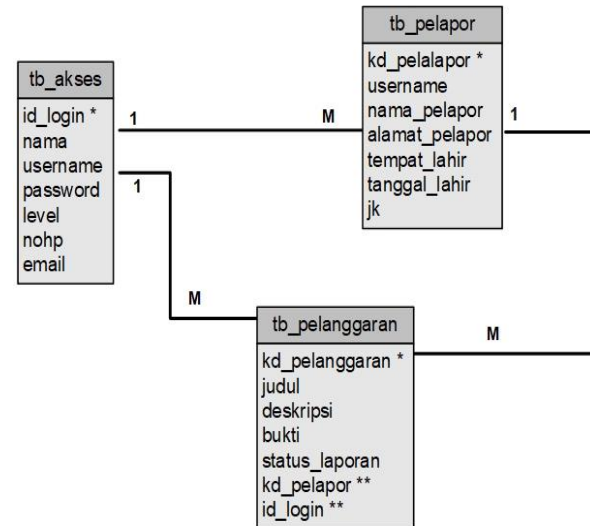


Figure 3. LRS Database

In Figure 3, the depiction of the diagram using the ERD transformation is presented in the form of LRS.

- Navigation Structure

A navigation structure describes how the various pages of your website are organized and connected to each other.

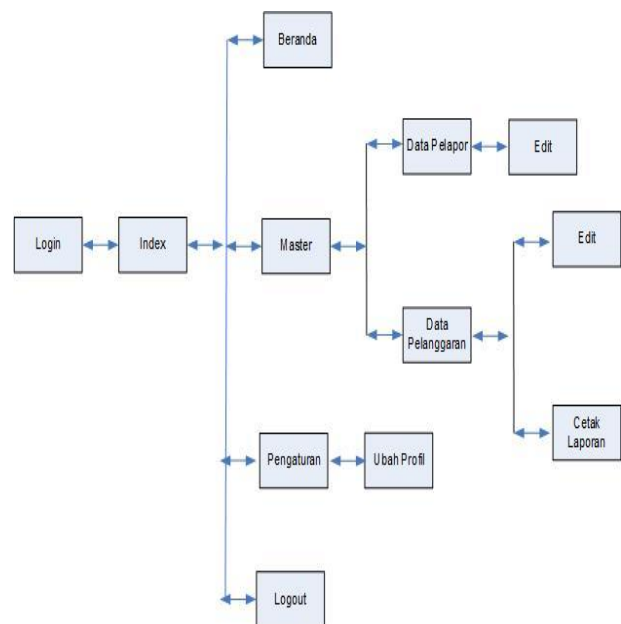


Figure 4. Admin Page Navigation Structure

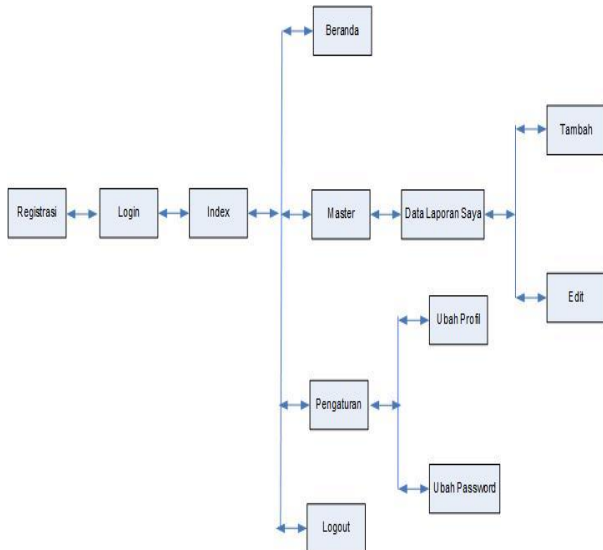


Figure 5. User Page Navigation Structure

**C. Coding, Testing, and Implementation**

Application development is done through program coding activities. PHP 7.0 was used as the programming language and MySQL 5.0 as the database during the development of this whistleblowing web-based application. Designing with the AdminLTE template.

Testing is carried out with blackbox testing which includes input and output processes, login form testing, form validation, and so on.

The results of the development and implementation of this web-based application are as follows:

**1. Register Page**

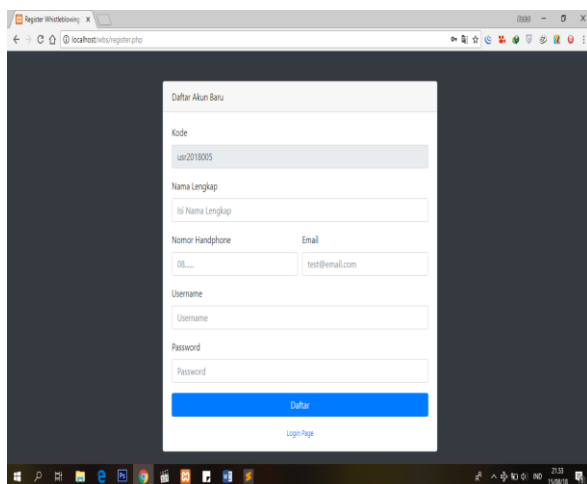


Figure 6. Register Page

This page is a page for users / complainants to create a new account to make a violation report.

**2. Login Page**

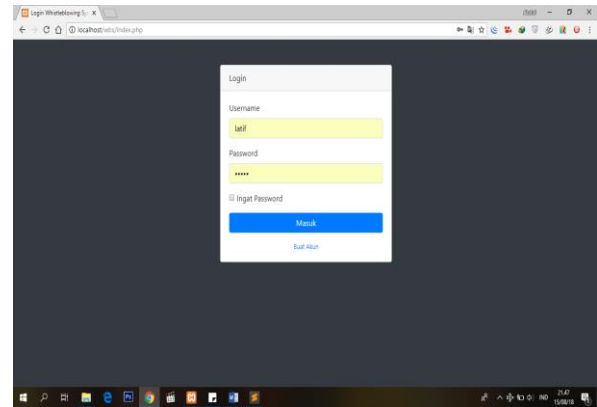


Figure 7. Login Page

After registering, users can login to the dashboard using the username and password that has been created.

**3. Dashboard Admin**

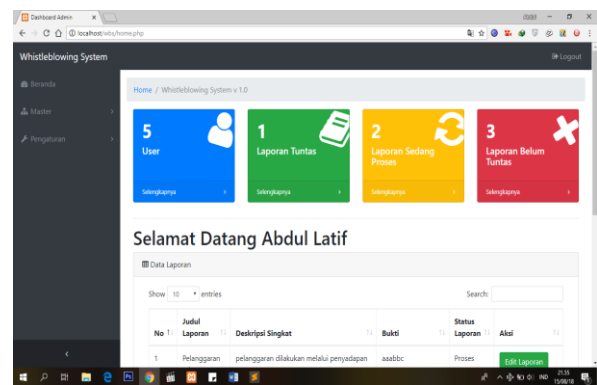


Figure 8. Admin Dashboard

This page contains all information including the number of users, a list of the number of reports, both completed and still in process.

**4. Violation/Complaint Page**

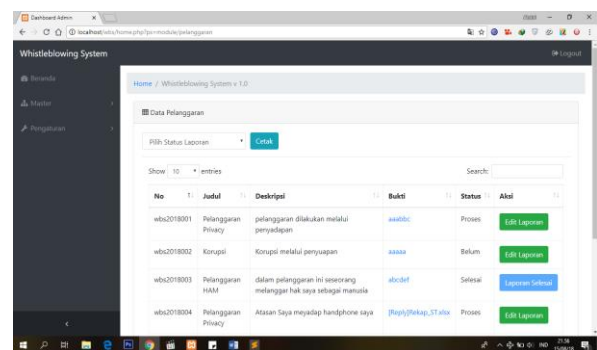


Figure 9. Complaint Page

This page will display all data on violations reported by the complainant, admins can verify report data, edit report status only, and print reports both based on status and all reports.

## 5. Profile Setting Page

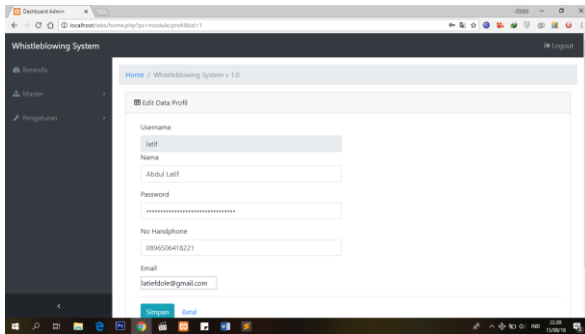


Figure 10. Profile Setting Page

On this page, users and admins can change their profile data.

## 6. Violation/Complaint Data Input Page

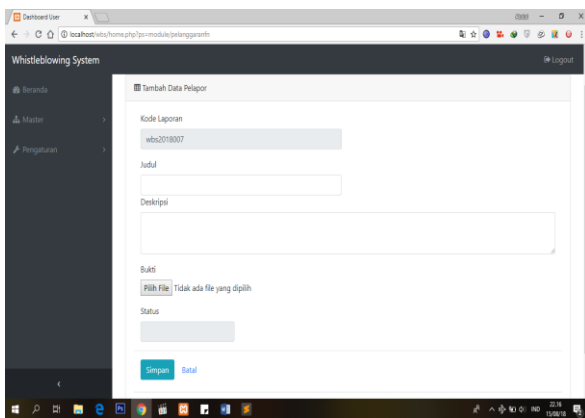


Figure 11. Complaint Data Input Page

On this page, users / reporters can report violations that occur without being able to identify them.

## D. Maintenance

The Whistleblowing web-based application can be accessed via a web browser and run on a variety of operating systems. System maintenance is done through regular database backups, resource control by CPanel hosting, and system upgrades in case of system changes.

## CONCLUSION

Based on the creation of an information system that implements the Rijndael algorithm on a website-based Whistleblowing system and various previous explanations above, it can be concluded that the Rijndael algorithm can be used to secure databases on a website-based whistleblowing system. So if a hacker manages to dump all or part of the tables from this whistleblowing application database, important data has been encrypted using

AES-256. To decrypt it requires a special key. In addition, each reporter no longer has to worry about the threat of leakage of his personal data, so he can remain anonymous and this can also be a witness protection program. This system can also make it easier for the audit team of a government agency or company to manage audit reports. The weakness in this system is that when encrypting data, this application still uses a constant decryption key and can only be changed from the source code. For further development, the decryption key can use a variable that can change. So that each user has their own encryption key. It also doesn't have a feature to encrypt files yet. Hopefully, the evidence file can also be encrypted. Another drawback is that the mcrypt module in PHP only has support for PHP version 7.2 and no longer supports the latest PHP versions.

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