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Comparison of Holt Winters and Simple Moving Average Models to Identify The Best Model for Predicting Flood Potential Based on The Normalized Difference Water Index.

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Abstract – Flood is a condition in which water cannot be accommodated in a drainage channel such as a river or river. An area is said to be flooded if the water in the area is inundated in large quantities so that it can cover all or most of a large area. Determining forecasting or prediction on a potential in the long or short term, especially changes in water content levels in an area, requires a method, model, or approach that must be well tested. The lower the error value in a model, the better the model for testing a forecast. One of the data that can be used for analysis of potential flood models is the use of remote sensing data with technology from Landsat 8. The advantage of sensing data from Landsat 8 is that it has data good history and allows to see changes in land cover from year to year in an area. The purpose of this study was to determine the best model for forecasting the potential for flooding in an area using the Holt Winters model and the Simple Moving Average. The result of this research is that the RMSE, MAE, MAPE, MSE values in the Holt Winters model are 0.03598683, 0.02748707, 0.13944356, 0.00129505 while the RMSE, MAE, MAPE, MSE values on the Simple Moving Average are 0, 09681483, 0.06338657, 0.53775228, 0.00937311. The Holt Winters model is the best model of the Simple Moving Average because the forecast error value has a low value.

Keywords: Flood, Forecasting, Holt Winters, Simple Moving Average, NDWI

I. INTRODUCTION

The current rate of global warming is extremely concerning. Flooding is one of the many natural disasters that have struck Indonesia as a result of the effects of global warming. A flood is a condition in which a region is inundated by large quantities of uncontrolled water flow, which inundates or strikes a region or settlement because the river cannot accommodate the overflowing water. Two factors can contribute to the occurrence of floods: natural factors and human factors[1], [2].

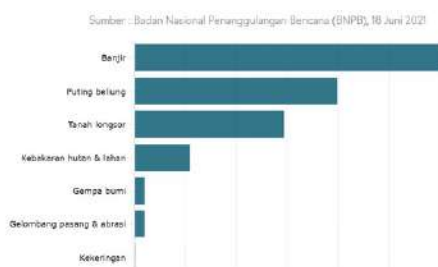


Figure 1. Disaster Data according to BNPB

Flood disasters can be predicted by monitoring precipitation and water flow. In addition to heavy rainfall, soil texture, land slope, and land use can also contribute to flooding. In general, floods frequently occur near watersheds. Sometimes, heavy precipitation can cause river reservoirs to exceed the volume of the river, leading to flooding.

Using remote sensing data from Landsat8 and the Normal Difference Water Index model to analyze the flood

potential model is one of the data that can be used. Based on calculations from previous remote sensing research titled (Development of an Inundated Area Identification Model Using Landsat[3]), the NDWI variable has a good ability to detect flood inundation. The benefits of remote sensing data include accurate historical information and the ability to observe annual changes in a region's land cover. The area coverage of the extensive remote sensing data enables a comprehensive view and analysis of the area, allowing the primary causes of flooding to be identified. This information can also be used as input for modeling potential flood zones.

Several previous studies related to forecasting using the Simple Moving Average [4] with the title (Prediction of PDAM Water Usage Using the Simple Moving Average Method) explained that this SMA was able to provide good predictive results, namely the MAPE value of 0.1712, where if the MAPE value is 10%, then the prediction results are categorized as good, as well as for related research for the Holt With values of = 0.1, = 0.001, and =0.5, the Holt-Winters method[5] yields better results than the SSA method with a MAPE of 13.469 percent.

Researchers are interested in developing research using Landsat 8 data with the NDWI (Normalized Difference Water Index) [6]feature and comparing the Simple Moving Average and Holt Winters models to determine the best model for making predictions based on previous research. In order to compare the two methods optimally, researchers will compare evaluation values including MAE, MAPE, MSE, and RMSE. Landsat 8's resolution is ideal for detecting, measuring, and analyzing changes in earth's surface objects at a granular level.



Landsat 8 is utilized because it is able to produce images for flood detection data processing[7]. The Normalized Difference Water Index (NDWI) feature is used to detect bodies of water. NDWI is a remote sensing-based identification method that is sensitive to changes in water content, according to publications [8] stating that an NDWI value greater than or equal to 0 indicates the water surface, whereas a value less than or equal to 0 indicates non-water level. The data that will be collected and used to predict potential flooding is based on two years of historical Landsat 8 data.

II. RESEARCH METHODOLOGY

According to a study by Sulistyanto [9] load cells are commonly used to measure force and torque. The load cell sensor will deliver accurate and dependable results when the load cell is used properly. The results of research and observations using the Level Two SMA Method and the Level Two WMA Method indicate that both methods have the ability to reduce socation well; however, the Level Two SMA method is superior to the Level Two WMA method in determining the reference point, as the reference point search is based on the data value when the load cell is stable. When conditions are stable, the standard deviation of the Level Two SMA Method and the Level Two WMA Method is 0.015572.

This study aims to predict monthly rainfall in Ambon City using the Holt-Winter Exponential Smoothing method [10]. This study makes use of monthly precipitation data from January 2005 to December 2016. The data is the result of observations made at the Ambon Meteorological, Climatology, and Geophysics Agency's Meteorological Station. According to data analysis, monthly precipitation in Ambon City follows a seasonal pattern. The results of this study indicate that the Holt-Winter model based on the seasonal multiplication method is a suitable model for forecasting monthly rainfall data in Ambon City due to its low SSE/RMSE value. The Holt-Winter model predicts that precipitation in Ambon City will increase next year.

In a study to compare the forecasting accuracy of the Holt Winters method and the Singular Spectrum Analysis model (SSI) [11], the difference in methods undoubtedly affects the accuracy of the predicted outcomes. The distinction between the three methods is determined by comparing the accuracy and dependability of the forecast results. Mean Absolute Percentage Error (MAPE) is used to measure the accuracy of forecasting, and tracking signal is used to measure the dependability of forecasting results. The application concerned the production of shallots in Indonesia from January 2006 to December 2015. Forecasting the two SSA methods using $L=39$ and $r=8$ grouping windows. With values of $\alpha=0.1$, $\beta=0.001$, and $\gamma=0.5$, the Holt-Winters additive method produced better results than the SSA method with a MAPE of 13,469 percent.

According to research [12], the Simple Moving Average is a predictive model. The moving average technique is employed to forecast demand by calculating the average value and actual demand value from a predetermined number of previous periods. As implied by the method's name, each new prediction is fixed to the previous period and used with requests from the new

period, so the data used in the calculation changes over time. The simple moving average method is utilized for unstable, trendless, and unweighted data. With the simple moving average method, which is one method for predicting system models based on time series with computerized characteristics, regarding predicting carpets, it is anticipated that the carpet laundry company will be able to predict the monthly income of the carpets in order to calculate the monthly profit ratio. In order to develop a user-friendly system for predicting the profit of a successful carpet cleaning business.

In a study authored by Laurensz [13] Floods are the most prevalent natural disasters in nearly all regions, and they can cause destruction, loss, and even loss of life. Volcanoes, archipelagos, and severe environmental degradation characterize this region. Standardized Precipitation Index (SPI), Normalized Difference Vegetation Index (NDVI), Normalized Difference Water Index (NDWI), Soil Adjusted Vegetation Index (SAVI), and Inverse Distance Weighted (IDW) are the analysis methods used in this study for data exploration with Quantum GIS (QGIS). In Manado during the rainy season, the NDVI value or greenness level of the vegetation index ranges from 0.451 to 0.639, indicating a high greenery vegetation index. And during the dry season, the index is between 0.44 and 0.61, indicating a high level of green vegetation. Using the NDWI method, it was determined that the level of wetness in Manado was moderate. According to the SAVI method, Manado has a range of values between -0.103 and 0.153, which indicates an abundance of puddles. According to the discussion, the subdistricts with the greatest potential for flooding in the city of Manado are Tuminting, Singkil, Paal Dua, Tikala, Wanea, Sario, Weneang, and Malalayang. Medium potential exists in the Bunaken District, while Mapanget District has little potential.

The results of the review of the five journals have some bearing on the similarities and differences in research[13]. In this study, remote sensing data or Landsat 8 technology were used to conduct research on an object or area. The benefits of sensing data from Landsat 8 include the availability of accurate historical data and the ability to observe changes in land cover from one year to the next. The NDWI (Normal Difference Water Index) variable has a strong ability to detect flood inundation[14].

In addition to a literature review, research utilizing the Simple Moving Average model demonstrates that SMA can be applied to the forecasting process due to the implementation of a relatively simple algorithm utilizing a number of actual data requests. new method for generating future demand forecast values. According to the Holt Winters model research published by Sinay, Pentury, and Anakotta (2017) the Holt-Winter method is a development of a simple exponential smoothing method that employs



three smoothing constants: the constant for smoothing the entire level, the constant for smoothing the trend (trend), and the constant for smoothing the season (seasonal).

III. RESEARCH METHODOLOGY

A. Analysis Techniques

In this analysis technique, researchers attempt to explain how the model process for solving a problem flows, so as to facilitate understanding of a model to be created. The analysis process is supported by collected data such as observations, literature studies, and Landsat 8 images of land objects[15]. In order to obtain the necessary specifications for this study, the several steps of the analysis procedure are as follows:

1. Collecting image object data from the USGS website using Landsat 8 technology from 1 May 2019 to 1 April 2021.
2. Performing Preprocessing of Data by Clipping
Typically, a satellite image has a coverage area that is too large to reflect the research area. To obtain a representation of the research area, it is necessary to clip the data, also known as clipping. The image that has been clipped using the QGIS application is transformed with NDWI to produce a water index or wetness index.
3. Visualize for forecasting the likelihood of high inundation or flooding based on the accuracy of the NDWI value using the Simple Moving Average and Holt Winters methods.
4. The final step is to evaluate the error stage by specifying values like RMSE, MAE, MAPE, and MSE (Mean Squared Error)

B. Design Techniques

At this stage, a system with the concept of an information retrieval system that can forecast the potential for flooding in an area and determine the best model from the Holt Winters model and the Simple Moving Average through evaluation tests will be developed. Figure 2 depicts an overview of the system that will be constructed.

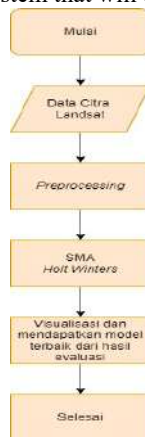


Figure 2. System Design Flowchart

C. Data Collection Method

During the research phase, data research becomes a critical element. Therefore, every researcher must comprehend the appropriate data collection techniques for the type of study being conducted[16].

1. Observation

Observations were made through direct observation of the research object. In this study, researchers used Bekasi as a single example of a location area. Using coordinates 6°14'06"S 106°59'32"E, it was determined that the research was conducted in the province of West Java. Figure 3 depicts the urban region of Bekasi.

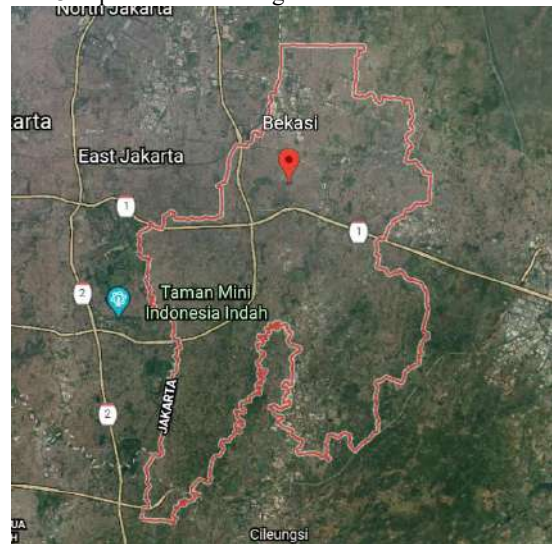


Figure 3. Area of Bekasi City

In general, the Bekasi City region has a tropical monsoon climate (Am) with a high humidity level of 78 percent. The daily climate conditions are extremely warm. This is particularly influenced by increased land use, particularly industry or commerce and human settlements. The estimated daily air temperature ranges between 24 °C and 33 °C. Bekasi City experiences two seasons due to its tropical monsoon climate: the rainy season and the dry season. The dry east-southeast monsoon influences the dry season in Bekasi City from early May to September, with August being the driest month. Meanwhile, the rainy season in Bekasi is influenced by the wet and humid southwest-northwest monsoon, which typically blows from November to March, with the peak of the rainy season occurring in January with more than 300 mm of rainfall per month (wikipedia).

2. Secondary Data

Secondary data is supplementary data obtained from research data sources through intermediary media or indirectly in the form of books, records, existing evidence, or archives, whether published or unpublished. This study's secondary data is comprised of literature studies from national and international journals and news articles from related websites. There are numerous supporting evidences. Researchers make use of precipitation data as secondary data. May 2019 to



April 2021 weather information retrieved from the website <https://id.weatherspark.com> (2 years). The weather and precipitation data can be found in table 1 below.

Table 1. Rainfall and Weather

	Curah Hujan	Curah Hujan /mm	Cuaca / Celcius
1	May-19	104	30
2	Jun-19	65.1	29
3	Jul-19	52.5	29
4	Aug-19	45.3	29
5	Sep-19	53.7	29
17	Sep-20	63.5	30
18	Oct-20	98	29
19	Nov-20	160	29
20	Dec-20	209.5	29
21	Jan-21	287.5	27
22	Feb-21	279	28
23	Mar-21	180.1	29
25	Apr-21	148.2	30

D. Testing Techniques

At this stage, the researcher will test or evaluate the constructed model in an effort to ensure that the model's execution is consistent with the research objectives. Scoring of RMSE (Root Mean Squared Error), MAE (Mean Absolute Error), and MSE (Mean Squared Error) is performed to determine the level of performance of the Simple Moving Average and Holt Winters models [17] applied to the dataset (Mean Squared Error). to obtain the ideal model.

IV. RESULT AND DISCUSSION

A. Data Collection

The primary data used by the author in this study are satellite images obtained by downloading data from <https://www.usgs.gov> between 1 May 2019 and 1 April 2021.

B. Preprocessing

After retrieving Landsat 8 image data, the data preprocessing stage is carried out. From the previous stage, it did not accurately represent the case study area, so it required further adjustments using clipping techniques; QGIS was used for the clipping stage. as displayed in image 4 below,

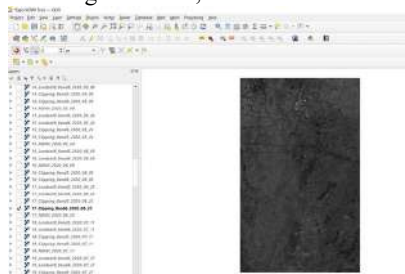


Figure 4. Clipping stage

When the clipping process is complete, the modeling stage, namely the transformation stage to obtain a water index

with the NDWI (Normal Different Water Index) feature, is executed. Using QGIS, satellite images that have undergone the clipping procedure are processed. Can be seen in Figure 5,

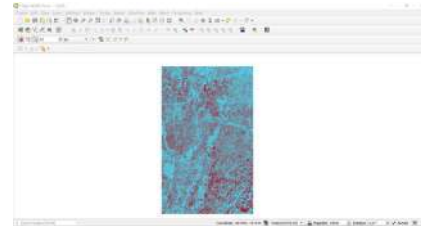


Figure 5. NDWI Layer Stacking Extraction Results on May 2019

After preprocessing, the Normalized Difference Water Index (NDWI) method is used to extract features. The level of validity in the research area is determined by transforming QGIS-processed raster data using the NDWI algorithm. Two spectral colors, namely red and blue, are assigned to raster data that has been modeled using NDWI. As shown in Figures 6, 7 and 8 below, the blue color represents land that has an ari value or a high level of water value validity, while the red color represents land that does not have a valid value.

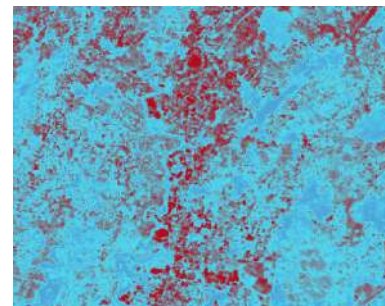


Figure 6. NDWI Results on May 2019

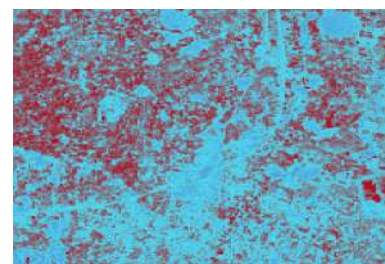


Figure 7. NDWI Results July 2019

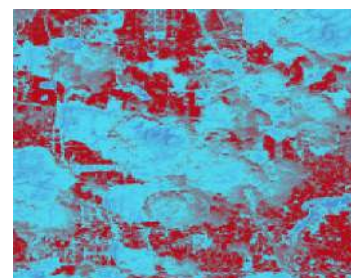


Figure 8. NDWI Results August 2020

After obtaining the image from the Normal Difference Water Index extraction feature, it is necessary to rasterize



the NDWI image using Python. Figure 9 demonstrates how data can be incorporated into a model, as demonstrated.

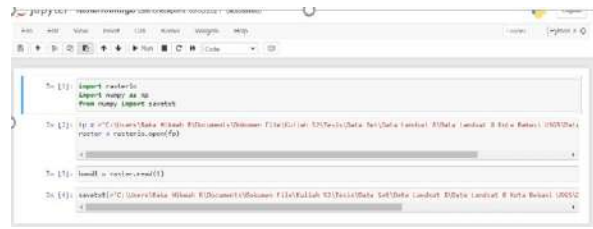


Figure 9. NDWI Raster Process

After completing the raster, a.csv file will be generated, as shown in Figure 10.

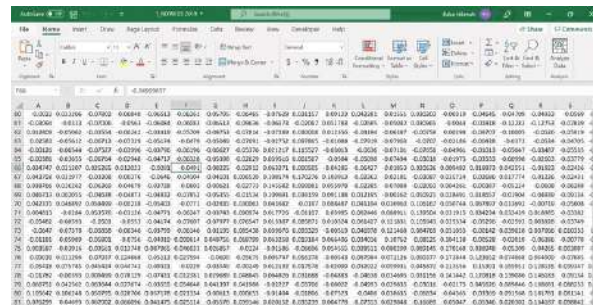


Figure 10. NDWI Raster Results on May 2019

From May 2019 to April 2021, a total of twenty-four data periods will be utilized. 1 period consists of 517 columns and 830 rows, with a total of 12,408 columns and 19,920 rows in each excel file containing 248,167,360 data points. The obtained data consists of a set of numbers representing each color pixel that has undergone the raster data process. Therefore, it is necessary to calculate the data in order to determine the average value of each period prior to processing the data.

After obtaining the raster's output data, search for the average value for each period of the raster's data. The data must be calculated to determine the average value for each period before they can be processed. Figure 11 illustrates this.

0.128711	0.206457	0.208202	0.171849	0.193818	0.164446
0.159874	0.244101	0.175113	0.192576	0.181743	0.16368
0.210854	0.239432	0.210525	0.166655	0.085876	0.12764
0.210615	0.215618	0.206246	0.171723	0.165115	0.16061
0.197042	0.200714	0.241386	0.207893	0.186871	0.21310
0.220881	0.235589	0.232327	0.233905	0.20716	0.21814
0.220659	0.233941	0.239855	0.292189	0.308703	0.26863
0.181834	0.162662	0.189046	0.254371	0.229943	0.22074
0.168695	0.13237	0.146919	0.167972	0.177198	0.12317
0.17835	0.147108	0.167982	0.147727	0.142776	0.17291
0.148075	0.162468	0.195572	0.140084	0.13915	0.18609
0.132181	0.167925	0.164288	0.137636	0.128818	0.2100
0.164652	0.18529	0.198704	0.162943	0.146947	0.18361
0.21264	0.173397	0.17414	0.160801	0.191191	0.20939

Average: 0.052767078 Count: 428280 Sum: 22599.0842

Figure 10. Calculation Results of the Average Value

C. Data Preparation

Following the completion of the hold preprocessing, the

data for the Simple Moving Average and Holt Winters models must be prepared. Following are data from each period based on the outcomes of the preprocessing procedure detailed in table 2.

Table 2. NDWI data for the whole period

	Nilai NDWI	Bulan-Tahun	Periode
1	0,05276708	May-19	1
2	0,11557148	Jun-19	2
3	0,05525897	Jul-19	3
24	0,09001209	Apr-21	24

D. Calculation of Holt Winters

This is a forecasting model for data with trend and seasonal patterns. The initial step in forecasting is determining the initial value (the overall smoothing value) or calling the level. This procedure involves substituting the value from the previous year.

So as to:

$$L_{12} = \frac{1}{12} + (0,05276708 + 0,11557148 + 0,05525897 + \dots + 0,11043278 + 0,09001209)$$

$$L_{12} = 0,10356897$$

After that, the level value in the 12th period was 0.10356897. After locating the initial value of the seasonal component (St) for the period 1 through 12, the value for the component period 1 through 12 is determined:

$$St_1 = 0,05276708 \div 0,10356897 = 0,50948737$$

$$St_2 = 0,11557148 \div 0,10356897 = 1,11588910$$

$$St_3 = 0,05525897 \div 0,10356897 = 0,53354757$$

After obtaining the initial value, a search is conducted for the overall smoothing value. From trend, level, and seasonal data, it is possible to estimate the parameter values to minimize errors based on previous experiments. The alpha constant value = 0.2, gamma = 0.2, and beta = 0.1 are constants for trend smoothing, level smoothing, and seasonal smoothing, respectively.

24 period

$$L_{24} = 0,2 \times (0,09001209 \div 1,01085039) + (1 + 0,2) \times (0,12244737 + 0,0004584) = 0,11613379$$

$$b_{24} = 0,1 \times (0,11613379 - 0,12244737) + (1 - 0,1) \times 0,0004584 = -0,0002188$$

$$S_{24} = 0,2 \times (0,09001209 \div 0,11613379) + (1 - 0,2) \times 1,01085039 = 0,96369479$$

$$F_{24} = (0,12244737 + -0,0004584) \times 1,01085039 = 0,12423934$$



After making a forecast for the period 1 to 24, the next step is to make a forecast for the next three months. The resulting value is as follows:

25 period

$$F_{25} = (0,11613379 + (1 \times -0,0002188) \times 0,50472699 = 0,05850542$$

26 period

$$F_{26} = (0,11613379 + (2 \times -0,0002188) \times 1,08147029 = 0,12559524$$

27 period

$$F_{27} = (0,11613379 + (3 \times -0,0002188) \times 0,54681018 = 0,06350314$$

Table 3. Holt Winters Method

Periode	NDWI	Level	Trend	Seasonal	Forecast
May-20	0,04972123	0,10356897	0	0,50472699	0,05276708
Jun-20	0,09292387	0,10237331	-0,0001196	1,08147029	0,11410384
Jul-20	0,06064582	0,09845768	-0,0004992	0,54681018	0,05226552
Feb-21	0,20777327	0,13006087	0,0015019	1,67770143	0,22323101
Mar-21	0,11043278	0,12974074	0,0013197	1,18436569	0,16447917
Apr-21	0,09001209	0,12244737	0,0004584	0,96369479	0,12423934

After calculating with NDWI data and the results of precipitation and weather forecasting data using the Holt Winters method, as shown in table 3, the results are presented.

E. Calculation of Simple Moving Average

Using a number of new actual demand data to generate forecast values for future demand is how the Simple Moving Average algorithm (moving average) is used for forecasting (M. S. Putra & Solikin, 2019). Simple moving averages are a straightforward method for forecasting (M. S. Putra & Solikin, 2019). SMA is quite effective in determining the current trend despite its simplicity.

To find a forecast, one must first determine the initial value. This process is carried out by substituting the value of the previous year or the first 12 periods with the value of the thirteenth forecast until the following value is obtained:

period 13

$$F_{13} = \frac{1}{12} + (0,05276708 + 0,11557148 + 0,05525897 + \dots + 0,17573213 + 0,12997773 + 0,10469273)$$

$$L_{13} = 0,10356897$$

24 period

$$F_{25} = \frac{1}{12} + (0,10469273 + 0,04972123 + 0,09292387 + \dots + 0,13482051 + 0,04972123 + 0,11043278)$$

$$L_{25} = 0,11203308$$

After making a forecast for the period 1 to 24, the next step is to make a forecast for the upcoming 1 month forecast. The value obtained is as follows:

25 period

$$F_{25} = \frac{1}{12} + (0,04972123 + 0,09292387 + 0,06064582 + \dots + 0,08777 + 0,05043 + 0,08001)$$

$$L_{25} = 0,11080970$$

F. Comparison of Holt Winters Model and Simple Moving Average

The forecasting results of the Holt Winters and Simple Moving Average models are shown in Table 4 below.

Table 4. Comparison Holt Winters and Simple Moving Average

Periode	NDWI	Holt Winters	Simple Moving Average
May-20	0,04972123	0,05276708	0,10356897
Jun-20	0,09292387	0,11410384	0,10331515
Jul-20	0,06064582	0,05226552	0,10142784
Feb-21	0,20777327	0,22323101	0,11099173
Mar-21	0,11043278	0,16447917	0,11366183
Apr-21	0,09001209	0,12423934	0,11203308

V. CONCLUSION

According to the findings of comparative research between the Holt Winters model and the Simple Moving Average, it can be concluded that:

1. The Holt Winters model's RMSE, MAE, MAPE, and MSE values are known to be 0.03598683, 0.02748707, 0.13944356, and 0.00129505, while the Simple Moving Average's values are 0.09682125, 0.06338657, 0.53775228, and 0.00937311.



2. The smaller the forecast error value, the more effective the model implementation.
3. The Holt Winters model is the superior model of the Simple Moving Average due to the day's low forecast error value.

In this study, 1 period's worth of image data is sufficient for 1 period's size, which is 900 MB. In this study, 24 periods (2 years) of image data were used, resulting in an image data size of 21,6 GB.

REFERENCES

- [1] Fitsolyna, B., Permana, A., Wardani, A. P. K., Veritawati, I., & Maspiyanti, F. (2019). Pencarian Rute Terpendek Menggunakan Metode Bellman Ford Berbasis Spasial pada Daerah Rawan Banjir dan Macet (Studi Kasus: Bekasi). *Jurnal Ilmiah FIFO*, 11(1), 11. <https://doi.org/10.22441/fifo.2019.v10i1.002>
- [2] Abdillah, G., Putra, F. A., Renaldi, F., Informatika, P. S., Jenderal, U., Yani, A., Barat, J., & Cimahi, K. (2016). PENERAPAN DATA MINING PEMAKAIAN AIR PELANGGAN UNTUK MENENTUKAN KLASIFIKASI POTENSI PEMAKAIAN AIR PELANGGAN BARU DI PDAM TIRTA RAHARJA MENGGUNAKAN ALGORITMA K-MEANS. *SENTIKA 2016*.
- [3] Suwarsono, Nugroho, J. T., & Wiweka. (2013). Identification of inundated area using normalized difference water index (NDWI) on lowland region of java island. *34th Asian Conference on Remote Sensing 2013, ACRS 2013*. <https://doi.org/10.30536/j.ijreses.2013.v10.a1850>
- [4] Fatimah, F., Tejawati, A., & Puspitasari, N. (2018). Prediksi Pemakaian Air PDAM Menggunakan Metode Simple Moving Average. *Jurnal Rekayasa Teknologi Informasi (JURTI)*. <https://doi.org/10.30872/jurti.v2i1.1410>
- [5] Utami, T. W., & Darsyah, M. Y. (2015). Peramalan Data Saham Dengan Model Winter ' S. *Statistika*, Vol. 3, No. 2, November 2015, 3(2), 1–4.
- [6] Darul, A., Irawan, D. E., Ajeng, R., Roekmi, K., & Oktavia, P. (2017). PRELIMINARY STUDY NORMALIZED DIFFERENCE WATER INDEX DI WILAYAH RESAPAN AIR TANAH KABUPATEN BEKASI. *Jurnal Geografi GEA*. <https://doi.org/http://dx.doi.org/10.17509/gea.v17i2.8134>
- [7] Chyan, P., Tetap, D., Teknologi, F., Atma, U., Makassar, J., Pendahuluan, I., & Digital, A. P. C. (2017). Penerapan Image Enhancement Algorithm Untuk Meningkatkan Kualitas Citra Tak Bergerak. 12, 278–281.
- [8] Anggraini, N., Marpaung, S., & Hartuti, M. (2018). ANALISIS PERUBAHAN GARIS PANTAI UJUNG PANGKAH DENGAN MENGGUNAKAN METODE EDGE DETECTION DAN NORMALIZED DIFFERENCE WATER INDEX (UJUNG PANGKAH SHORELINE CHANGE ANALYSIS USING EDGE DETECTION METHOD AND NORMALIZED DIFFERENCE WATER INDEX). *Jurnal Penginderaan Jauh Dan Pengolahan Data Citra Digital*. <https://doi.org/10.30536/j.pjpdcd.1017.v14.a2545>
- [9] Sulistyanto, P., Wahyunggoro, O., & Cahyadi, A. I. (2015). *Pengolahan Isyarat Load cell Menggunakan Metode Simple Moving Average Tingkat Dua dan Weighted Moving Average Tingkat Dua untuk Pencarian Titik Referensi*. 31–35.
- [10] Sinay, L. J., Pentury, T., & Anakotta, D. (2017). PERAMALAN CURAH HUJAN DI KOTA AMBON MENGGUNAKAN METODE HOLT-WINTERS EXPONENTIAL SMOOTHING. *BAREKENG: Jurnal Ilmu Matematika Dan Terapan*. <https://doi.org/10.30598/barekengvol11iss2pp101-108>
- [11] Jatmiko, Y. A., Rahayu, R. L., & Darmawan, G. (2017). Perbandingan Keakuratan Hasil Peramalan Produksi Bawang Merah Metode Holt-Winters dengan Singular Spectrum Analysis (SSA). *Jurnal Matematika "MANTIK."* <https://doi.org/10.15642/mantik.2017.3.1.13-22>
- [12] Aini, N., Sinurat, S., & Hutabarat, S. A. (2018). Penerapan Metode Simple Moving Average Untuk Memprediksi Hasil Laba Laundry Karpet Pada CV. Homecare. *JURIKOM (Jurnal Riset Komputer)*, 5(2), 167–175. <http://ejournal.stmik-budidarma.ac.id/index.php/jurikom/article/view/656>
- [13] Laurensz, B., Lawalata, F., Yulianto, S., & Prasetyo, J. (2018). Potensi Resiko Banjir dengan Menggunakan Citra Satelit (Studi Kasus: Kota Manado, Provinsi Sulawesi Utara). *Indonesian Journal of Computing and Modeling*.
- [14] Szabó, S., Gácsi, Z., & Balázs, B. (2016). Specific features of NDVI, NDWI and MNDWI as reflected in land cover categories. *Landscape & Environment*. <https://doi.org/10.21120/le/10/3-4/13>
- [15] Dawwas, R. H., Darlis, D., & Novianti, A. (2020). Sistem Informasi Untuk Absensi Berbasis Image Processing Information System for Absention Based on Image Processing. *E-Proceeding of Applied Science*.
- [16] Kanah, A. P., & Novera, H. (2018). Pemilihan Teknik Sampling Berdasarkan Perhitungan Efisiensi Relatif. *Jurnal Statistika*.
- [17] Staviana, E., Kusriani, K., & Luthfi, E. T. (2020). Sistem Peramalan Kebutuhan Stok Obat Menggunakan Metode Holt-Winters. *Jurnal Informa: Jurnal Penelitian Dan Pengabdian Masyarakat*. <https://doi.org/10.46808/informa.v5i4.154>



Decision Support System to Select The Best Customers Using Analytical Hierarchy Process (AHP) Methods, Simple Additive Weighting (SAW) Method, Weight Aggregated Sum Product Assessment Method (WASPAS) at kebaya Shop

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Abstract – Style Queen Kebaya Store (SQ Kebaya) is a store that is engaged in apparel, its product sales focus includes adult and children's kebaya. The negative impact of the Covid 19 Pandemic has proven that the Store (SQ Kebaya) has experienced a decline in sales turnover in 2020, therefore the SQ Kebaya Store's efforts to restore its sales activities are by giving gifts for customer appreciation during the COVID 19 season through selecting the best customers for the 2020 period. However, the problem faced by SQ Kebaya Stores in the process of evaluating the best customer selection is that there is no criterion weight so that the decision making is not right on target, making the best customer decisions less efficient because they have to look for customer sales records manually in the sales record book. This study produces a web-based decision support system for selecting the best customers at SQ Kebaya Stores using the AHP (criteria weight), SAW and WASPAS (best customer ranking) methods, this study produces priority weights and importance levels of each criterion, namely status (0.37), method of payment (0.23), total spending (0.14), quantity (0.13), intensity of visits (0.07), length of subscription (0.07) and the result of ranking the percentage of the largest alternative value is the alternative SAW method with an average of 0.6952, while the WASPAS method is 0.6405. It can be concluded that the right method used to obtain the best alternative value is the SAW method.

Keywords - SQ Kebaya, SPK, Best Customer, AHP, SAW, WASPAS

I. INTRODUCTION

Store SQ or SQ Kebaya Store is a store engaged in the sale of apparel, the focus of its product sales includes adult and children's kebaya, batik skirts, songket skirts, adult men's shirts and children of various sizes. Competition in the world of trade, especially in the era of COVID 19, is getting tougher, one of which is in the Tanah Abang Wholesale Center area, Central Jakarta, apparel traders are very aggressively carrying out various attractive product marketing promotions, which aim to increase purchasing power and customer enthusiasm for the products being marketed. , maintain the existence of stores, as well as keep buying and selling activities running during the COVID 19 season. The negative impact of this COVID 19 Pandemic has made SQ Kebaya Store's revenue decrease in turnover by 40% to 60% each month from January to August 2020. In responding to this The owner of the SQ Kebaya Store plans to give gifts to the best wholesale and retail customers who meet the shop owner's evaluation criteria during the 2020 period for their loyal appreciation of being customers at SQ Kebaya Stores during the COVID 19 season. This gift-giving activity has taken place before in 2017. 2019, but not be going well and not on target giving gifts to customers, because shop owners have problems choosing the best customers, some of the obstacles faced by SQ Kebaya shop owners

in determining the best customers are still using *hardcopy* (notebooks) in collecting sales transaction data, there is no weight For each criterion used in the assessment of the best customer selection, it is difficult to make efficient decisions due to the absence of a decision support system for selecting the best customer. From some of the obstacles obtained, a Decision Support System (DSS) is needed that can help SQ Kebaya Stores in choosing the best customers. This study tries to develop a Decision Making System using the *Analytical Hierarchy Process* (AHP) method for weighting criteria, *Simple Additive Weighting* (SAW) and the *Weight Aggregated Sum Product Assessment* (WASPAS) method. to find out the ranking of the best customer selection decisions. Several previous studies that have the same object of study as [1] make a Decision Support System (DSS) application design using the *Simple Additive Weighting* (SAW) to determine the best customer, then research from [2] made a Decision Support System (DSS) application with the *Analytical Hierarchy Process* (AHP) & *Weight Sum Model* (WSM) method for the selection of the *Customer Award Recipient*, and [3] made a Decision Support System (SPK) to determine the best customer in a building store using the WASPAS method.



A. Decision Support System

According to Penerapan Metode Profile Matching Untuk Menentukan Pemberian Reward Terhadap Pelanggan Pada Bisnis Ritel [4] Decision Support System (DSS) is a system designed to assist *decision makers* in making decisions. With the DSS, a decision is expected to be more similar to a decision that should be based on complete and perfect information. Two elements contained in the DSS are boundaries and guidelines. The limit in question is the extent and method of SPK in limiting the decisions of its users. Meanwhile, guidelines mean the extent and way of SPK providing guidance for users in making decisions.

B. Customers

Explaining that customers or customers are individuals or groups who are accustomed to buying a product or service based on their decisions based on considerations of benefits and prices who then make contact with the company via telephone, mail, and other facilities to get a new offer from the company[5].

C. Analytical Hierarchy Process (AHP) Method

According to [6],[7]AHP is a decision-making method that involves a number of criteria and alternatives selected based on consideration of all related criteria in a hierarchical form. With a hierarchy, a complex problem can be broken down into groups which are then arranged hierarchically so that the problem will look more structured and systematic.

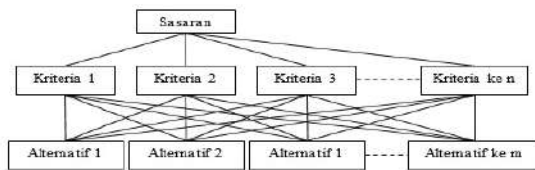


Figure I. Structure of the Analytical Hierarchy Process (AHP)

In detail, describes the procedures and steps of the *Analytical Hierarchy Process* (AHP), namely:

- Creating a pairwise comparison matrix of each specified criterion.
- Specifies the priority of the element. 1) Make pair comparisons by comparing elements in pairs according to the given criteria. 2) Each pairwise comparison matrix is filled in by using numbers to describe the relative priority level between elements.
- Synthesis is a combination of considerations against pairwise comparisons to obtain ordered priorities.
- Measuring Consistency which means that in making a decision, it is important to know how much consistency there is to avoid low consistency.
- Calculating *Consistency*
- Calculating the ratio *Consistency Index* (CI).

- Calculating *Consistency Index* (CI) with equation (2.1)

$$CI = \frac{\lambda_{max} - n}{n - 1} \quad (1)$$

Where n is the number of elements

- Calculate *Consistency Ratio* (CR) with equation (2.2)

$$CR = \frac{CI}{IR} \quad (2)$$

Where IR is the *Random Consistency Index* with values as shown in table (2.1):

Table I. Value of Indes Random Consistency

Matrix Size	IR Value
1.2	0.00
3	0.58
4	0.90
5	1.12
6	1.24
7	1.32
8	1.41
9	1.45
10	1.49
11	1.51
12	1.48
13	1.56
14	1.57
15	1.59
	Checking

The consistency of the hierarchy. If the value is more than 10%, then the data judgment assessment must be corrected. However, if the consistency ratio (CI/IR) is less or equal to 0.1 then the results of the calculations that have been carried out can be declared correct.

D. Method Simple Additive Weighting (SAW)

The SAW method is often also known as the weighted addition method. The basic concept of the SAW method is to find the weighted sum of the performance ratings for each alternative on all attributes. The SAW method requires the process of normalizing the decision matrix (X) to a scale that can be compared with all existing alternative ratings.

The steps of the SAW method are [8]:

- Determine the criteria that will be used as a reference in making decisions.
- Determine the suitability rating of each alternative on each criterion.
- Make a decision matrix based on criteria (C), then normalize the matrix based on the equation that is adjusted to the type of attribute so that a normalized matrix R is
- The final result is obtained from the ranking process, namely the addition of the multiplication of the normalized matrix R with the weight vector so that the largest value is chosen as an alternative best (A) as the solution.

The formula for normalization is:



- a. variable *benefit* with the equation (2.3)

$$r_{ij} = \frac{x_{ij}}{\text{Max}_{ij}} \quad (3)$$

- b. variable *cost* with the equation (2.4)

$$r_{ij} = \frac{\text{Min}_{ij}}{x_{ij}} \quad (4)$$

Where:

- r_{ij} = Performance rating normalized
 Max_{ij} = Maximum value of each row and column
 Min_{ij} = Minimum value of each row and column
 x_{ij} = Rows and columns of matrix

Where r_{ij} is the normalized performance rating of alternative A_i on attribute C_j ; $i = 1, 2, \dots, m$ and $j = 1, 2, \dots, n$

The preference value for each alternative (V_i) is given as:

$$V_i = \sum_{j=1}^n W_j R_{ij} \quad (2.5)$$

Where:

- V_i = Final value of alternative
 W_j = Weight that has been determined
 $r_{greater}$ = Normalization matrix
 value V_i indicates that alternative A_{method} is preferred

E. Weight Aggregated Sum Product Assessment (WASPAS)

The WASPAS method is to find the priority of the most preferred location in accordance with using weighting [9] The *Weighted Aggregated Sum Product Assessment* (WASPAS) method is a method that can reduce errors or optimize the estimation for the selection of the highest and lowest values. Thus, the main objective of the MCDM approaches approach is to select the best option from a set of alternatives in the face of various conflicting criteria.. The calculation process step applies the WASPAS method .

1. Create a decision matrix
2. Normalize the x matrix, *benefit / cost*
3. Calculate the value of Qi

$$Qi \quad (2.7)$$

$$= 0.5 \sum_{j=1}^n x_{ijw} + 0.5 \prod_{j=1}^n x_{ijw}$$

$$= 1 (x_{ij}) w_j$$

Where

- Q_i : Value from Q to i
 x_{ijw} : Multiply the value of x_{ijw} with a weight (w)
 0.5 :

The best alternative is the alternative that has the highest Qi value

F. Unified Modeling Language (UML)

According to [9] *Unified Modeling Language* (UML) was introduced to analyze object-oriented modules and requirements with assistance *use-case* and actor UML is a widely used modeling language for software analysis, design, and implementation. Developers . can easily do software development using UML

G. Black Box Testing (BBT)

According to [10] *Black box testing* is testing software in terms of functional specifications without testing the design and program code. *Black box testing* is the stage used to test the smoothness of the program that has been created. This test is important to do so that there are no errors in the flow of the program that has been made.

H. Technology Acceptance Method (TAM)

The *Technology Acceptance Model* (TAM) is an adaptation of the *Theory of Reasoned Action Model* (TRA). This model was developed by Fred D. Davis in 1986. TAM is a theory that describes the behavior of technology users in accepting and using new technology. TAM has two main variables that are used to predict acceptance of use, namely perceived usefulness and perceived ease of use which will affect attitudes towards use, behavioral intentions to use and ultimately indicate *actual system use* [11].

II. RESEARCH METHODOLOGY

A. Research Methods

This research is a quantitative research method where there are certain populations and samples to be processed. In more detail, the quantitative data in this study came from the results of weighting criteria in the process of selecting the best customers at SQ Kebaya Stores using the *Analytical Hierarchy Process* (AHP) method. In addition, the *Simple Additive Weighting* (SAW) method and the *Weight Aggregated Sum Product Assessment* (WASPAS) method are used to obtain alternative ranking results as one of the final decisions.

B. Population and Sample Selection Methods The

Population in this study are customers at the SQ Kebaya Store, the sample that will be used is the prospective customer data at the SQ Kebaya Store. The sample selection method used is *non-probability sampling* which depends more on the ability and limitations of the researcher in drawing samples. The *non-probability sampling technique* used is *purposive sampling*. *Purposive sampling* is a non-probability technique that is often used because of its simplicity. This sample selection method is considered more



suitable because the author can adjust the sample to the existing population.

C. Data Collection Methods The data

Collection methods used in this study are:

- 1 Interview (*interview*)
In this study is the owner of the SQ Kebaya Store, namely Elvi Yanti, which aims to be able to collect information on how the process of choosing the best customers at SQ Kebaya Stores and what criteria and weights used in making decisions in selecting the best customers.
- 2 Observation (*observation*)
Observation at SQ Kebaya Store aims to find out how the process of choosing the best customers and find out how the owner of the SQ Kebaya Store chooses the best customers.
- 3 Literature Study
The method of collecting data is obtained by studying, researching, and reading books, information from the internet, journals, theses related to the selection of the best customers.
- 4 Internal
Data The internal data used in this study is the customer data of the SQ Kebaya Store.

D. Instrumentation The instrumentation

Used in this study was a questionnaire designed to collect data and test the system. The instrumentation are:

- 1 Questionnaire weight criteria.
The criterion weight questionnaire was provided by the researcher to determine the assessment criteria in choosing the best customers at the SQ store kebaya.
- 2 Technology *Technology Acceptance Model* (TAM) Questionnaire The *Acceptance Model* (TAM) [12] questionnaire was provided by researchers to determine the level of user acceptance of the decision support system application to be developed.

E. Analysis Techniques, Design and Testing

1 Analytical

Techniques The analysis technique used in this study uses an object-oriented analysis approach with UML. The analysis process is carried out on the results of the stages of data collection with interviews and literature studies to obtain specifications for the system requirements to be developed. In the analysis process, the analytical techniques used are:

- Analysis of data and information obtained from interviews, questionnaires and literature studies.
- Analysis of functional, non-functional, and user requirements. Functional requirements modeling to describe the system functions and the users involved and what functions can be obtained by each user are modeled with *use case diagrams*.

- System actor analysis. At this stage, an analysis of system actors is carried out which is developed and modeled with *use cases* that run in the system.
- In this study, the best customer selection technique uses the *Analytical Hierarchy Process* (AHP) method for weighting the criteria, *Simple Additive Weighting* (SAW) and the *Weight Aggregated Sum Product Assessment* (WASPAS) method to determine the final total value of the sum of all the largest alternative values which will later be The SAW or WASPAS method is chosen to be used to determine the best customer ranking results.

2 Design Techniques

In designing and developing a *prototype* decision support system to choose the best customers at the SQ Kebaya Store, the author uses the *prototyping* proposed by Roger S Pressman, where there are 5 main stages in the process, namely *communication*, *quick plan*, *modeling quick plan*, *construction of prototype* and *deployment delivery & feedback*. The first stage of *communication*, the author tries to communicate and identify the general concept and design of the *prototype* by asking directly the owner of the SQ Kebaya Store which is adjusted to the results of the AHP, SAW and WASPAS analysis. In the second stage, the author will start planning the *prototype of the DSS*, namely the *quick plan*, then carry out the design, namely the *quick plan modeling* in the third stage. At the design stage, the author uses the *Unified Modeling Language* (UML) tool, while in the implementation stage the author uses several *tools*, namely PHP *Hypertext Preprocessor* (PHP) and *database*. The fourth stage is the *construction of prototyping DSS*, at this stage the *prototype* begins to be developed in accordance with the planning and design in the previous stage. The fifth stage is *deployment delivery & feedback*. At the last stage, the *prototype* is put into use and tested, repairs will be made immediately if there are deficiencies.

3. Testing Techniques

System testing is carried out using the *blackbox testing* [13] to identify the reliability and functionality of the decision support system application later. After it is deemed appropriate, a *Test Acceptance Model* (TAM) [14],[15] will then be carried out to find out how far the level of user acceptance is for using the application (Decision Support System) to choose the best customer. A TAM questionnaire will be prepared to be filled out by users containing their assessment of the application.

III. RESULTS AND DISCUSSION

A. Alternative

The author uses a *non-probability sampling method*. In this research, the population is shop customers proposed by the owner of the SQ Kebaya Store in 2020



as many as 225 customers. For criteria the length of subscription is calculated based on the number of days, for example 648 days.

Table III. Example of Alternative Data Research

No	Customer	Intensity Visit	Long Subscription	Payment method	Total Shopping	Quantity	Status
1	Abdullah	3	648	Cash	863.000	20	Paid Off
2	Abdul	1	435	Cash	50.000	1	Paid Off
3	Luar	3	593	Cash	509.000	10	Paid Off
4	Ada Padang	2	648	Cash	234.000	4	Paid Off
5	Adib	1	620	Cash	80.000	1	Paid Off
6	Adni	1	588	Cash	42.000	1	Paid Off
7	Agustis	1	589	Cash	208.000	4	Paid Off
8	Amber	1	450	Cash	75.000	1	Paid Off
9	Amber	1	574	Cash	48.000	1	Paid Off
225	Zanal	1	438	Cash	70.000	1	Paid Off

B. Method Analytical Hierarchy Process (AHP)

At this stage the author begins to determine and weight the criteria, the determination of the criteria has been determined by the owner of the SQ Kebaya Store, and to determine the weight of the criteria obtained from the results of the criteria weight questionnaire which was previously filled in by the Store Owner. SQ Kebaya. The calculation results are as in table IV.

Table IV. Pairwise Comparison Matrix

	Status	Payment method	Total Shopping	Quantity	Intensity Visit	Long Subscription
Status	1,00	2/1	3/1	3/1	5/1	4/1
Payment method	1/2	1,00	2/1	2/1	4/1	3/1
Total Shopping	1/3	1/2	1,00	1,00	2/1	3/1
Quantity	1/3	1/2	1,00	1,00	2/1	2/1
Intensity Visit	1/5	1/4	1/2	1/2	1,00	1,00
Long Subscription	1/4	1/3	1/3	1/2	1,00	1,00

Table V. Pairwise Comparison Matrix Values in Decimal

	Status	Payment method	Total Shopping	Quantity	Intensity Visit	Long Subscription
Status	1,00	2,00	3,00	3,00	5,00	4,00
Payment method	0,50	1,00	2,00	2,00	4,00	3,00
Total Shopping	0,33	0,50	1,00	1,00	2,00	3,00
Quantity	0,33	0,50	1,00	1,00	2,00	2,00
Intensity Visit	0,20	0,25	0,50	0,50	1,00	1,00
Long Subscription	0,25	0,33	0,33	0,50	1,00	1,00
TOTAL	2,62	4,58	7,83	8,00	15,00	14,00

In Table V, there is a row TOTAL which is the result of the sum of all rows in each criterion. The details of the calculation are as follows:

$$C1=1.00+0.50+0.33+0.33+0.20+0.25=2.62$$

$$C2=2.00+1.00+0.50+0.50+0.25+0.33=4.58$$

$$C3=3.00+2.00+1.00+1.00+0.50+0.33=7.83$$

$$C4=3.00+2.00+1.00+1.00+0.50+0.50=8.00$$

$$C5=5.00+4.00+2.00+2.00+1.00+1.00=15.00$$

$$C6=4.00+3.00+3.00+2.00+1.00+1.00=14.00$$

Table VI. Matrix Normalization

	Status	Payment method	Total Shopping	Quantity	Intensity Visit	Long Subscription
Status	0,38	0,44	0,38	0,38	0,33	0,29
Payment method	0,19	0,22	0,26	0,25	0,27	0,21
Total Shopping	0,13	0,11	0,13	0,13	0,13	0,21
Quantity	0,13	0,11	0,13	0,13	0,13	0,14
Intensity Visit	0,08	0,05	0,06	0,06	0,07	0,07
Long Subscription	0,10	0,07	0,04	0,06	0,07	0,07
TOTAL	1,00	1,00	1,00	1,00	1,00	1,00

Details of the calculation of the matrix normalization value in Table VI are as follows:

Status (C1)	Total Belanja (C3)	Intensitas Kunjungan (C5)
C1: 1.00/2.62=0.38	C1: 3.00/7.83=0.38	C1: 5.00/15.00=0.33
C2: 0.50/2.62=0.19	C2: 2.00/7.83=0.26	C2: 4.00/15.00=0.27
C3: 0.33/2.62=0.13	C3: 1.00/7.83=0.13	C3: 2.00/15.00=0.13
C4: 0.33/2.62=0.13	C4: 1.00/7.83=0.13	C4: 2.00/15.00=0.13
C5: 0.20/2.62=0.08	C5: 0.50/7.83=0.06	C5: 1.00/15.00=0.07
C6: 0.25/2.62=0.10	C6: 0.33/7.83=0.04	C6: 1.00/15.00=0.07
Cara Pembayaran (C2)	Kuantitas (C4)	Lama Berlangganan (C6)
C1: 2.00/4.58=0.44	C1: 3.00/8.00=0.38	C1: 4.00/14.00=0.29
C2: 1.00/4.58=0.22	C2: 2.00/8.00=0.25	C2: 3.00/14.00=0.21
C3: 0.50/4.58=0.11	C3: 1.00/8.00=0.13	C3: 3.00/14.00=0.21
C4: 0.50/4.58=0.11	C4: 1.00/8.00=0.13	C4: 2.00/14.00=0.14
C5: 0.25/4.58=0.05	C5: 0.50/8.00=0.06	C5: 1.00/14.00=0.07
C6: 0.33/4.58=0.07	C6: 0.50/8.00=0.06	C6: 1.00/14.00=0.07

Table VII. Eigen Vector

	Status	Payment method	Total Shopping	Quantity	Intensity Visit	Long Subscription
Status	0,38	0,44	0,38	0,38	0,33	0,29
Payment method	0,19	0,22	0,26	0,25	0,27	0,21
Total Shopping	0,13	0,11	0,13	0,13	0,13	0,21
Quantity	0,13	0,11	0,13	0,13	0,13	0,14
Intensity Visit	0,08	0,05	0,06	0,06	0,07	0,07
Long Subscription	0,10	0,07	0,04	0,06	0,07	0,07
TOTAL	1,00	1,00	1,00	1,00	1,00	1,00

Details of priority weight calculation (eigen vector) in Table VII are as follows:

$$C1: (0.38+0.44+0.38+0.38+0.33+0.29)/6 = 0.37$$

$$C2: (0.19+0.22+0.26+0.25+0.27+0.21)/6 = 0.23$$

$$C3: (0.13+0.11+0.13+0.13+0.13+0.21)/6 = 0.14$$

$$C4: (0.13+0.11+0.13+0.13+0.13+0.14)/6 = 0.13$$

$$C5: (0.08+0.05+0.06+0.06+0.07+0.07)/6 = 0.07$$

$$C6: (0.10+0.07+0.04+0.06+0.07+0.07)/6 = 0.07$$

Table VIII. Pairwise Comparison Value Multiply By Weight (Maximum Eigen)



	Status	Payment method	Total Shopping	Quantity	Intensity Visit	Long Subscription	Weight	Vector
Status	1,00	2,00	3,00	5,00	5,00	4,00	0,37	2,236
Payment method	0,50	1,00	2,00	2,00	4,00	3,00	0,23	1,419
Total Shopping	0,33	0,50	1,00	1,00	2,00	3,00	0,14	0,843
Quantity	0,33	0,50	1,00	1,00	2,00	3,00	0,13	0,774
Intensity Visit	0,20	0,25	0,50	0,50	1,00	1,00	0,07	0,399
Long Subscription	0,25	0,33	0,33	0,50	1,00	1,00	0,07	0,414

Details for calculating the *vector* are as follows:
C1: $(1.00 \cdot 0.37) + (2.00 \cdot 0.23) + (3.00 \cdot 0.14) + (3.00 \cdot 0.13) + (5.00 \cdot 0.07) + (4.00 \cdot 0.07) = 2.236$
C2: $(0.50 \cdot 0.37) + (1.00 \cdot 0.23) + (2.00 \cdot 0.14) + (2.00 \cdot 0.13) + (4.00 \cdot 0.07) + (3.00 \cdot 0.07) = 1.419$
C3: $(0.33 \cdot 0.37) + (0.50 \cdot 0.23) + (1.00 \cdot 0.14) + (1.00 \cdot 0.13) + (2.00 \cdot 0.07) + (3.00 \cdot 0.07) = 0.843$
C4: $(0.33 \cdot 0.37) + (0.50 \cdot 0.23) + (1.00 \cdot 0.14) + (1.00 \cdot 0.13) + (2.00 \cdot 0.07) + (2.00 \cdot 0.07) = 0.774$
C5: $(0.20 \cdot 0.37) + (0.25 \cdot 0.23) + (0.50 \cdot 0.14) + (0.50 \cdot 0.13) + (1.00 \cdot 0.07) + (1.00 \cdot 0.07) = 0.399$
C6: $(0.25 \cdot 0.37) + (0.33 \cdot 0.23) + (0.33 \cdot 0.14) + (0.50 \cdot 0.13) + (1.00 \cdot 0.07) + (1.00 \cdot 0.07) = 0.413$

Table IX. The results of the division of vector values to priority weights. The

Criteria	Vector	Weight	Result (λ)
Status (C1)	2,236	0,37	6,1
Payment method (C2)	1,419	0,23	6,1
Total Shopping (C3)	0,843	0,14	6,0
Quantity (C4)	0,774	0,13	6,1
Intensity Visit (C5)	0,399	0,07	6,1
Long Subscription (C6)	0,414	0,07	6,0

Details of the calculation are as follows:

$$\begin{aligned} C1: & 2.236/0.37=6.1 \\ C2: & 1.419/0.23=6.1 \\ C3: & 0.843/0.14=6.0 \\ C4: & 0.774/0.13=6.1 \\ C5: & 0.399/0.07=6.1 \\ C6: & 0.414/0.07=6.0 \end{aligned}$$

$$\max = \frac{(6.1 + 6.1 + 6.0 + 6.1 + 6.1 + 6.0)}{6} = 6.1$$

$$(Consistency Index) CI = \frac{(6.1 - 6)}{(6 - 1)} = 0.014$$

If the value of CR < 0.1 then the data and calculations are considered consistent, but if CR > 0.1, then need to be recalculated.

$$(Consistency Ratio) CR = \frac{0.014}{1.24} = 0.0112$$

From the results of the calculation of the CR value, obtained CR < 0.1 which indicates the consistency of the



calculation. Thus, the value of the priority weight or *eigenvector* obtained can be used in this study.

C. Simple Additive Weighting (SAW) Method and Weight Aggregated Sum Product Assessment (WASPAS) Method

Table X. Attributes of Each Criteria for Best Customer Selection at SQ Kebaya

No	Criteria	Criteria Name	Atribut	Weight
1	C1	Intensity Visit	Benefit	0,37
5	C2	Long Subscription	Benefit	0,23
3	C2	Payment method	Benefit	0,14
2	C4	Total Shopping	Benefit	0,13
4	C5	Quantity	Benefit	0,07
6	C6	Status	Benefit	0,07

Table XI. Crips Data for Each Best Customer Criteria for SQ Kebaya Store

Criteria Code	Criteria Name	Crips	Score
C1	Intensity Visit	> 24	5
C1	Intensity Visit	20 sd 24	4
C1	Intensity Visit	13 sd 19	3
C1	Intensity Visit	7 sd 12	2
C1	Intensity Visit	< 6	1
C2	Long Subscription	> 24 Month	5
C2	Long Subscription	19 sd 24 Month	4
C2	Long Subscription	13 sd 19 Month	3
C2	Long Subscription	6 sd 12 Month	2
C2	Long Subscription	< 6 Month	1
C3	Payment method	Cash	5
C3	Payment method	Credit	1
C4	Total Shopping	> Rp. 50.000.000	5
C4	Total Shopping	Rp. 10.000.000 sd Rp. 50.0000	4
C4	Total Shopping	Rp. 5.000.000 sd Rp. 10.000.000	3
C4	Total Shopping	Rp. 500.000 sd Rp. 5.000.000	2
C4	Total Shopping	< Rp. 500.000	1
C5	Quantity	> 200	5
C5	Quantity	150 sd 200	4
C5	Quantity	100 sd 150	3
C5	Quantity	50 sd 100	2
C5	Quantity	1 sd 50	1
C6	Status	Paid Off	5
C6	Status	Not Yet Paid Off	1

Table XII. Alternative Attribute Values Based on Crips Data Conversion

No	Customer	Intensity Visit	Long Subscription	Payment method	Total Shopping	Quantity	Status
		Benefit	Benefit	Benefit	Benefit	Benefit	Benefit
1	Abdoh	1	3	5	2	1	5
2	Abdul	1	4	5	1	1	5
3	Abdoh Luar	1	4	5	2	1	5
4	Adi Padang	1	4	5	1	1	5
5	Adib	1	4	5	1	1	5
6	Adi	1	4	5	1	1	5
7	Agustin	1	4	5	1	1	5
8	Amsar	1	3	5	1	1	5
9	Amsar	1	4	5	1	1	5
225	Zainal	1	3	5	1	1	5

- Normalization SAW & WASPAS Method

a. Visit Intensity
Because of the benefits, then look for max (1,2,3) = 3

$$r_{11} = \frac{1}{3} = 0.33$$

$$r_{21} = \frac{1}{3} = 0.33$$

$$r_{31} = \frac{1}{3} = 0.33$$

$$\dots$$

$$r_{2251} = \frac{1}{3} = 0.33$$

c. Payment Methods
Because of the benefits, then find max (1,5) = 5

$$r_{13} = \frac{5}{5} = 1$$

$$r_{23} = \frac{5}{5} = 1$$

$$r_{33} = \frac{5}{5} = 0,1$$

$$\dots$$

$$r_{2253} = \frac{5}{5} = 1$$

e. Quantity
Because of the benefit, then find max (1,2,3,4,5) = 5

$$r_{15} = \frac{1}{5} = 0.2$$

$$r_{25} = \frac{1}{5} = 0.2$$

$$r_{35} = \frac{1}{5} = 0.2$$

$$\dots$$

$$r_{2255} = \frac{1}{5} = 0.2$$

b. Length of subscription
Due to benefits, then find max (2,3,4) = 4

$$r_{12} = \frac{4}{4} = 1$$

$$r_{22} = \frac{3}{4} = 0.75$$

$$r_{32} = \frac{4}{4} = 1$$

$$\dots$$

$$r_{2252} = \frac{3}{4} = 0.75$$

d. Total Expenditure
Due to benefits, then find max (1,2,3,4) = 4

$$r_{14} = \frac{2}{4} = 0.5$$

$$r_{24} = \frac{1}{4} = 0.25$$

$$r_{34} = \frac{2}{4} = 0.5$$

$$\dots$$

$$r_{2254} = \frac{1}{4} = 0.25$$

f. Status
Because of the benefits, then find max (1,5) = 5

$$r_{16} = \frac{5}{5} = 1$$

$$r_{26} = \frac{5}{5} = 1$$

$$r_{36} = \frac{5}{5} = 1$$

$$\dots$$

$$r_{2256} = \frac{5}{5} = 1$$

Table XIII. Normalization Result of Alternative

No	Customer	Intensity Visit	Long Subscription	Payment method	Total Shopping	Quantity	Status
		(0,07)	(0,07)	(0,23)	(0,14)	(0,13)	(0,37)
1	Abdoh	0,33	1	1	0,3	0,2	1
2	Abdul	0,33	0,75	1	0,25	0,2	1
3	Abdoh Luar	0,33	1	1	0,3	0,2	1
4	Adi Padang	0,33	1	1	0,25	0,2	1
5	Adib	0,33	1	1	0,25	0,2	1
6	Adi	0,33	1	1	0,25	0,2	1
7	Agustin	0,33	1	1	0,25	0,2	1
8	Amsar	0,33	0,75	1	0,25	0,2	1
9	Amsar	0,33	1	1	0,25	0,2	1
225	Zainal	0,33	0,75	1	0,25	0,2	1

1 Value Calculating Alternative Value

- Calculating Alternative Value of SAW Method
The calculation of alternative value of SAW method is as follows:

$$V_1 = (0.07 * 0.33) + (0.07 * 1) + (0.23 * 1) + (0.14 * 0.5) + (0.13 * 0.2) + (0.37 * 1) = 0.78933$$

$$V_2 = (0.07 * 0.33) + (0.07 * 0.75) + (0.23 * 1) + (0.14 * 0.25) + (0.13 * 0.2) + (0.37 * 1) = 0.73683$$

$$V_3 = (0.07 * 0.33) + (0.07 * 1) + (0.23 * 1) + (0.14 * 0.5) + (0.13 * 0.2) + (0.37 * 0.1) = 0.78933$$

...

$$V_{225} = (0.07 * 0.33) + (0.07 * 0.75) + (0.23 * 1) + (0.14 * 0.25) + (0.13 * 0.2) + (0.37 * 1) = 0.73683$$

- Calculating the Alternative Value of the WASPAS Method

The calculation of the alternative value of the WASPAS method is as follows:

$$Q_1 = 0.5 \sum (0.33 * 0.07) + (1 * 0.07) + (1 * 0.23) + (0.5 * 0.14) + (0.2 * 0.13) + (1 * 0.37) = 0.5 \sum (0.39467) = 0.5 \sum (0.33^{0.07}) * (1^{0.07}) * (1^{0.23}) * (0.5^{0.14}) * (0.2^{0.13}) * (1^{0.37}) = 0.5 \prod (0.34085) = 0.5 \sum (0.39467 + 0.5) (\prod 0.34085) = 0.5 * (0.39467) + 0.5 * (0.34085) = 0.73552$$

$$Q_2 = 0.5 \sum (0.33 * 0.07) + (0.75 * 0.07) + (1 * 0.23) + (0.25 * 0.14) + (0.2 * 0.13) + (1 * 0.37) = 0.5 \sum (0.36842) = 0.5 \sum (0.33^{0.07}) * (0.75^{0.07}) * (1^{0.23}) * (0.25^{0.14}) * (0.2^{0.13}) * (1^{0.37}) = 0.5 \prod (0.30316) = 0.5 \sum (0.36842 + 0.5) (\prod 0.30316) = 0.5 * (0.36842) + 0.5 * (0.30316) = 0.67158$$

$$Q_3 = 0.5 \sum (0.33 * 0.07) + (1 * 0.07) + (1 * 0.23) + (0.5 * 0.14) + (0.2 * 0.13) + (1 * 0.37) = 0.5 \sum (0.39467) = 0.5 \sum (0.33^{0.07}) * (1^{0.07}) * (1^{0.23}) * (0.5^{0.14}) * (0.2^{0.13}) * (1^{0.37}) = 0.5 \prod (0.34085) = 0.5 \sum (0.39467 + 0.5) (\prod 0.34085) = 0.5 * (0.39467) + 0.5 * (0.34085) = 0.73552$$

$$Q_4 = 0.5 \sum (0.33 * 0.07) + (0.75 * 0.07) + (1 * 0.23) + (0.25 * 0.14) + (0.2 * 0.13) + (1 * 0.37) = 0.5 \sum (0.36842) = 0.5 \sum (0.33^{0.07}) * (0.75^{0.07}) * (1^{0.23}) * (0.25^{0.14}) * (0.2^{0.13}) * (1^{0.37}) = 0.5 \prod (0.30316) = 0.5 \sum (0.36842) + 0.5 \prod (0.30316) = 0.5 * (0.36842) + 0.5 * (0.30316) = 0.67158$$

2 Calculating Alternative Ranking

Table XIV. Ranking Results of the Best Customers at SQ Kebaya



Ranking	SAW		WASPAS	
	Customer	Score	Customer	Score
1	Bang Ibrahim Palembang	0,9667	Bang Ibrahim Palembang	0,9635
2	Bang Ando Kalimantan	0,9333	Bang Ando Kalimantan	0,9146
3	Nia Blok B	0,9025	Nia Blok B	0,8948
4	Sobirin Ciseang	0,8733	Sobirin Ciseang	0,8516
5	Uda Ramji	0,8658	Uda Ramji	0,8479
6	Bang Azar Bakasi	0,8658	Bang Azar Bakasi	0,8479
7	Fatih Anak Babeh	0,8392	Fatih Anak Babeh	0,8204
8	Nando Kalimantan	0,8108	Nando Kalimantan	0,7916
9	Koh Edi	0,8058	Bang Doni	0,7780
225	Nia Dukuh	0,2758	Nia Dukuh	0,2621
	Average	0,6952		0,6405

From table XIV the results of the ranking above show the largest percentage of alternative values, namely the results of the alternative SAW method with an average of 0.6952, while the WASPAS method is 0.6405. It can be concluded that the right method and can be used to obtain the largest alternative in the case of making the decision to choose the best customer at the SQ Kebaya Store is the SAW method where the final value of a large alternative indicates that the best alternative is preferred [9]. It is hoped that this SAW method is appropriate to use to select the best customers at the SQ Kebaya Store.

D. System Design

At this stage, the author uses *the Unified Modeling Language (UML)* tool to describe the system design in general. The results of the design can later be used as documentation for future system development.

Protyope Design



Figure II. Transaction Page Display



Figure III. Alternative Page Views



Image IV. Image Conversion Alternative Page Views



V. SAW Normalization Page Display

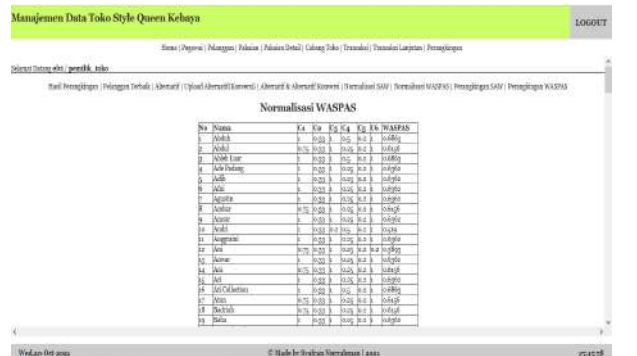


Figure VI. The Alert Normalization Page Display



Figure VII. Best Customer Ranking Results Page Display



E. Testing Prototype

1. Testing Black Box Testing (BBT)

At this stage testing of the SQ Store web application, the test is carried out by running the SQ Kebaya Store web application by *inputting, editing, deleting, searching, printing, uploading* data and see *output* is as expected.

2. Testing Technology Acceptance Method (TAM) Testing Questionnaire

Table XV. Results of Respondents' Recap of Perceive Usefulness Construct (*Perceive Usefulness*)

Name	Part	Question					
		1	2	3	4	5	6
Elvi Yanti	Shop Owner	5	5	5	5	5	5
Alfina Diniati	Shop Employee	4	4	4	5	5	5
M. Fatah	Shop Employee	5	5	4	4	5	5
Titi Suryati	Shop Employee	5	5	5	5	5	5
Nanda Pratiwi	Shop Employee	4	5	4	4	4	5

Table XVI. Results of Respondents' Recap of Perceive Ease of Use (*Perceive Ease of Use*)

Name	Part	Question				
		1	2	3	4	5
Elvi Yanti	Pemilik Toko	5	5	5	4	5
Alfina Diniati	Pegawai Toko	4	5	4	3	5
M. Fatah	Pegawai Toko	5	5	5	3	5
Titi Suryati	Pegawai Toko	5	5	5	5	5
Nanda Pratiwi	Pegawai Toko	5	5	4	5	5

Table XVII. Results of Respondents' Recap of User Acceptance (*User Acceptance*)

Name	Part	Question			
		1	2	3	4
Elvi Yanti	Pemilik Toko	4	5	5	5
Alfina Diniati	Pegawai Toko	4	4	5	5
M. Fatah	Pegawai Toko	4	4	5	5
Titi Suryati	Pegawai Toko	4	4	5	5
Nanda Pratiwi	Pegawai Toko	4	5	5	5

Table XVIII. Percentage of Likert Scale Score

Score Interval	Description
0% - 19,99%	Strongly Disagree
20% - 39,99%	Don't agree
40% - 59,99%	Neutral
60% - 79,99%	Agree
80% - 100%	Strongly agree

Table XIX. Results of Calculation of Percentage of Useful Perceived

Code	Weight	Question						Total
		1	2	3	4	5	6	
SA	5	1	3	1	2	3	4	14
A	4	4	1	2	2	2	1	12
N	3	0	1	1	1	0	0	3
DA	2	0	0	0	0	0	0	0
SD	1	0	0	0	0	0	0	0
Number of respondents		5	5	5	5	5	5	
Skor Aktual		21	22	16	21	23	24	127
Ideal Score		25	25	25	25	25	25	150

$$\text{Score \% Actual Score} = \frac{127}{150} * 100 = 84.7\%$$

Table XX. Calculation Results Percentage Score Perception of Ease

Code	Weight	Question					Total
		1	2	3	4	5	
SA	5	3	0	1	0	3	7

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A	4	2	4	2	3	2	13
N	3	0	1	2	2	0	5
DA	2	0	0	0	0	0	0
SD	1	0	0	0	0	0	0
Number of respondents		5	5	5	5	5	
Skor Aktual		23	19	19	18	23	102
Ideal Score		25	25	25	25	25	125

$$\% \text{ Actual Score} = \frac{102}{125} * 100 = 81.6\%$$

Table XXI. Calculation Results Percentage Score User Acceptance

Code	Weight	Question				Total
		1	2	3	4	
SA	5	0	0	2	5	7
A	4	2	3	3	0	8
N	3	3	2	0	0	5
DA	2	0	0	0	0	0
SD	1	0	0	0	0	0
Number of respondents		5	5	5	5	
Actual Score		17	18	22	25	82
Ideal Score		25	25	25	25	100

$$\% \text{ Actual Score} = \frac{82}{100} * 100 = 82\%$$

Table XXII. Conclusion Testing

No	Testing Aspect	Actual Score	Ideal Score	% Ideal Score	Description
1.	Useful Perception	127	150	84,7 %	Strongly Agree
2.	Perception of Ease	102	125	81,6 %	Strongly Agree
3.	User Acceptance Perception	82	100	82 %	Strongly Agree

IV. CONCLUSION

A. Conclusion

Based on the problems, literature study, research reviews, research objects and research methodology in the decision support system to choose the best customers at SQ Stores Kebaya with AHP, SAW, and WASPAS methods. So it can be concluded as follows:

1. This research produces a web-based decision support system with the AHP method as a weighting method and gets the results of the priority weights and importance levels of each criterion, namely status (0.37), payment method (0.23), total spending (0.14). Store owners be SQ accurate (right on target) in choosing the best customers.
2. The results of ranking the best customers obtained the largest percentage of alternative values, namely the results of the alternative value of the SAW method with an average of 0.6952, while the WASPAS method was 0.6405. It can be concluded that the right method and can be used to obtain the optimal best alternative in the case of making the decision to choose the best customer at the SQ Store Kebaya is the SAW method. So it is hoped that this

SAW method is used appropriately to choose the best customers at SQ Stores kebaya.

3. The results of the *User Acceptance Test* (UAT) test using the *Technology Acceptance Method* (TAM) by emphasizing on 3 aspects of the test. The result of the percentage score based on the Usability aspect is 84.7%, the percentage score for the Convenience aspect is 81.6% and the percentage score for the User Acceptance aspect is 82%. In general, the percentage of the UAT score in this study was 82.7% and based on the score interval it can be concluded that the user Strongly Agrees with the Decision Support System (DSS) for Selecting the Best Customers by Using the *Analytical Hierarchy Process* (AHP), *Method Simple Additive Weighting Method* (PBUH) and *Stores Weight Aggregated Sum Product Assessment* (WASPAS) Method at SQ kebaya.

B. Suggestions

Based on the conclusions of existing research, the suggestions that the authors give for the development of a Decision Support System (DSS) to Choose the Best Customers Using the *Simple Additive Weighting* (SAW) and *Method Weight Aggregated Sum Product Assessment* (WASPAS) pada Toko SQ Kebaya yaitu:

1. This research can be continued with different decision support system methods in selecting the best customer, and the information system model can be developed even better.
2. The SQ Kebaya Store can provide input and suggestions for improvements to the research that has been done.

REFERENCES

- [1] Indina, F., Purnama, I., & Harahap, S. Z. (2021). *Analisa Metode SAW Dalam SPK Penentuan Pelanggan Terbaik*. 4(2), 7–14.
- [2] Hasonongan, A. R. (2020). Sistem Pendukung Keputusan Pemilihan Customer Terbaik Penerima Penghargaan Menggunakan Metode AHP (Analytical Hierarchy Process) Dan WSM (Weight *Pelita Informatika: Informasi Dan*
- [3] Khoiriah, Z. (2018). Sistem Pendukung Keputusan Menentukan Pelanggan Terbaik Ditoko Bangunan Menggunakan Metode WASPAS. *Seminar Nasional Sains & Teknologi Informasi (SENSASI)*, 673–679.
- [4] Apriana, V. (2018). PENERAPAN METODE PROFILE MATCHING UNTUK MENENTUKAN PEMBERIAN REWARD TERHADAP PELANGGAN PADA BISNIS RITEL. *Jurnal Pilar Nusa Mandiri*.
- [5] Canellas, M. C., Feigh, K. M., & Chua, Z. K. (2015). Accuracy and Effort of Decision-Making Strategies with Incomplete Information: Implications for Decision Support System Design. *IEEE Transactions on Human-Machine Systems*.
<https://doi.org/10.1109/THMS.2015.2420575>
- [6] Saaty, T. L. (2004). Decision making — the Analytic Hierarchy and Network Processes (AHP/ANP). *Journal of Systems Science and Systems Engineering*. <https://doi.org/10.1007/s11518-006-0151-5>
- [7] Görener, a. (2012). Comparing AHP and ANP: An Application of Strategic Decisions Making in a Manufacturing Company. *International Journal of Business and Social Science*.
- [8] Sinaga, A. S. R. M. (2019). Sistem Pendukung Keputusan Menentukan Karyawan Terbaik Dengan Metode AHP. *JISKA (Jurnal Informatika Sunan Kalijaga)*.
<https://doi.org/10.14421/jiska.2018.32-06>
- [9] Marbun, E. D., Simanjuntak, E. R., Siregar, D., & Afriany, J. (2018). Penerapan Metode Weighted Aggregated Sum Product Assessment Dalam Menentukan Tepung Terbaik Untuk Memproduksi Bihun. *Jurnal Riset Komputer (JURIKOM)*, 5(1), 24–28.
- [10] Shaikh, A., & Wiil, U. K. (2018). Overview of Slicing and Feedback Techniques for Efficient Verification of UML/OCL Class Diagrams. *IEEE Access*.
<https://doi.org/10.1109/ACCESS.2018.2797695>
- [11] Sukamto, R. A., & Shalahuddin, M. (2016). Rekayasa Perangkat Lunak. *UML (Unified Modeling Language)*, 4, 133–171.
- [12] Harb, Y., & Alhayajneh, S. (2019). Intention to use BI tools: Integrating technology acceptance model (TAM) and personality trait model. *2019 IEEE Jordan International Joint Conference on Electrical Engineering and Information Technology, JEEIT 2019 - Proceedings*.
<https://doi.org/10.1109/JEEIT.2019.8717407>
- [13] Kaprocki, Z., Pekovic, V., & Velikic, G. (2017). Combined testing approach: Increased efficiency of black box testing. *2015 IEEE 1st International Workshop on Consumer Electronics - Novi Sad, CE WS 2015*.
<https://doi.org/10.1109/CEWS.2015.7867160>
- [14] Aeni Hidayah, N., Hasanati, N., Novela Putri, R., Fiqry Musa, K., Nihayah, Z., & Muin, A. (2020). Analysis Using the Technology Acceptance Model (TAM) and DeLone McLean Information System (DM IS) Success Model of AIS Mobile User Acceptance. *2020 8th International Conference on Cyber and IT Service Management, CITSM 2020*.
<https://doi.org/10.1109/CITSM50537.2020.9268859>
- [15] Inayatulloh. (2020). Technology acceptance model (TAM) for the implementation of knowledge acquired model for SME. *Proceedings of 2020 International Conference on Information Management and Technology, ICIMTech 2020*.
<https://doi.org/10.1109/ICIMTech50083.2020.9211279>



Implementation of The Patas Model in The Development of The Matana University Graduation Information System

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Abstract – There is an urgent need to make a graduation information system at Matana university. This system is needed, especially for students, secretariat, and finance. Several other things to consider, namely the number of participants and the graduation committee are more than 300 people, delegation of system development to one person, many users are still unfamiliar with integrated information systems based on information technology (IS/IT), the Corona pandemic, and can anticipate sudden changes. Therefore, we need a software development model that fits these conditions. The research methods for making this model, such as study of literature, interview, observation, model creating and model testing. This software development model is called Patas (Cepat Terbatas), it is rapid and limited. This model has six phases, i.e., user requirements, selection of devices, modification, evaluation, implementation, and maintenance. This model is then implemented to the development of Matana University graduation information system (MUGIS). MUGIS based on web has been successfully built using the Patas model. MUGIS features prospective graduate registration, payment, sending information to participants (personal or mass) by email, dashboard, privileges user, attendance for graduates by QR Code, change profile and content management. MUGIS is used from graduation preparation to graduation day. Thus, the Patas model can be an alternative model in software development. To use the Patas model, an expert is needed. In the future, the Patas model needs to be tried for the development of a different information system or software.

Keywords – Patas Model, Software Development, Graduation Information System, QRCode, Web

I. INTRODUCTION

In 2021, Matana University (MU) will graduate its students. At this graduation, I started to think about utilizing the graduation information system (GIS), inspired when MU successfully held the 2019 SLKI (Seminar dan Lokakarya Kualitatif Indonesia)[1]. The existence of GIS is expected to assist in the capture, process and distribution of data and information from preparation to the event.

The Corona pandemic was still ongoing when the 3rd MU graduation was being prepared[2]. Therefore, GIS is expected to be able to help the presence of graduation participants on the graduation day, to avoid crowds (social distancing) and presence with shared ballpoint. GIS core users are graduation participants, secretariat section, and finance section, where they have access rights to GIS. The secretariat section not only requires data such as profiles of graduation participants along with photos and sizes of gowns and their presence on graduation day, but also sends information or announcements. The finance section requires profile data and payment of graduation participants. Graduation participants need information regarding schedules, invitations, QR Code for presence. It is known that the number of graduation participants and committee members is more than 300 people, many of whom are not used to using integrated GIS. GIS development is delegated to one person, who can anticipate sudden changes or additional needs, where development time is short.

Of course, it is not easy to develop GIS integrated with these conditions. Although there are many models of software development [3], [4], they are not necessarily suitable for the conditions encountered. Therefore, a software development model is needed that is in

accordance with the conditions encountered to be able to respond to it and then apply it so that it can produce the desired integrated GIS immediately.

In previous studies, used the Prototyping[1] and Scrum[5] models, but the systems developed and the conditions were different. Several campuses have developed graduation information systems[6],[7],[8], or digital graduation management system[9]. The development of the system not only has a different background or context, but also the development model and its features. Several software development models in Indonesia are mostly carried out using the Waterfall or Prototyping models, rarely developing their own models according to the conditions encountered. Most of the GIS developed are web-based. This is because it can be accessed easily through a browser on personal computers, notebooks, tablets, or smartphones. PHP is a popular programming language in Indonesia for creating web-based programs or applications[10],[11].

The background and context for the development of the Matana University graduation information system (MUGIS) are certainly different. No development model fits the background or context yet. It is necessary to identify it first to determine the successful development model [12]. Therefore, it is necessary to have a suitable model to produce such integrated GIS immediately, MUGIS.

This research resulted in a software development model that was implemented to the development of MUGIS. In addition, a web-based integrated graduation information system was also produced between graduation participants, the secretariat section, and the finance section.



II. RESEARCH METHODOLOGY

The research method used is as shown in Figure 1, consisting of study of literature, interview, observation, model creating and model testing.

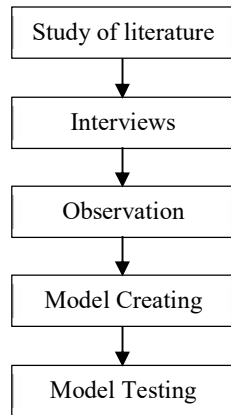


Figure 1. Research method

Study of literature to obtain an overview of previous studies related to the development of MUGIS, software development models and software engineering.

Interview, interviewing several people to find out the needs and specifications of the integrated GIS. Interviewed users, such as committee chairmen, PIC of the secretariat and PIC of the finance.

Observation, observation of related documents, services, software, and hardware available. Observations were also made on several users. Observation results help in determining the tools to be used in development MUGIS.

Model Making, the model is made by approaching the conditions encountered, and the expertise of the delegated person. Many applications do not need to be made from scratch, but can take advantage of applications or programs that are deliberately shared for free on github such as PHPMailer[13], sourceforge such as PHP QR Code[14], books such as creating a CMS[15] or other sites, such as jQuery[16], Bootstrap[17] and of course there are many more that can be utilized. To suit the needs, the application or program that is shared needs to be modified. However, in the model it is necessary to anticipate the additional needs or changes that the user wants. Before implementation, it needs to be evaluated by the user. After implementation, it needs to be monitored for improvements if errors or problems still occur.

Model Testing, the model was tested to be implemented to the development of a web-based integrated MUGIS. The results of this testing will provide useful feedback to improve the model.

III. RESULTS AND DISCUSSION

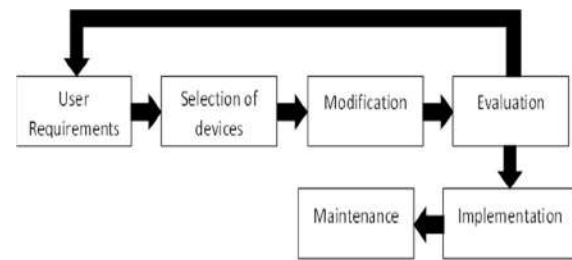


Figure 2. Patas model

The model for MUGIS development was successfully created, called Patas. The abbreviation of Patas is Cepat Terbatas (in Bahasa), Rapid Limited (in English), Figure 2. The Patas model has 6 phases, i.e., user requirements, selection of devices, modification, evaluation, implementation, and maintenance. From evaluation, you can return to user requirements to accommodate user needs or changes.

User requirements, this phase is to find out the needs or specifications of the user for the system to be developed. At this phase, the basic and important requirements are first obtained in order to obtain an overview of the system being built.

Selection of devices, based on the requirements and specifications obtained, is then followed by searching for the appropriate devices to develop the system. Example: shared use of open source or free software. Efforts are made to select for the appropriate devices that are easy to learn and have adequate documentation.

Modification, not all the selected tools are in accordance with the needs of the user or developer. At this phase, modifications can be made by adding or removing features, integrating with other programs or applications or systems.

Evaluation, the system that has been built needs to be evaluated. The results of this evaluation inform whether the needs of the user have been accommodated. At this phase, it is possible to return to the user requirements phase to accommodate additional needs or changes that occur. However, instead, it will be passed on to the implementation phase.

At the implementation phase, installation, data migration and training are carried out. After everything is ready and suitable for use, proceed to the maintenance phase.

Maintenance is the final phase. At this phase it is carried out for repairs - minor repairs, data backup.

The following is the result of applying the Patas model to develop GIS at Matana University. Figure 3, is the homepage of the Matana University GIS, which is made in the form of a content management system (CMS) with homepage features, about us, news, galleries, agendas, guidelines, search, and login.





Figure 3. Homepage

These GIS users can login to gain access rights. The login form can be seen in Figure 4. Each user will have their's features.



Figure 4. Form login

Graduation participants have dashboard, profile, registration, and installment payment features, as shown in Figure 5. In the page, graduation participants can input data like graduation service (online or offline), upload receipt of payment/transfer, choose the size of the gown, upload photos and notes to the committee.



Figure 5. Page for graduation participants

The secretariat section has dashboard features, profiles, info and participants, Figure 6. The secretariat can monitor graduation participants, those who registered or not, paid or not, the total number of graduation participants. Not only that, but also can send emails privately or blast.



Figure 6. Page for secretariat section

The finance section has dashboard, profile, info and participant features, Figure 7. Apart from being able to monitor graduation participants. The finance section can change the student registration status to "Registered (Paid)" if the payment has been made.



Figure 7. Page for finance section

CMS is managed by Admin. Some CMS features such as CMS configuration, gallery, news, announcements, adding users, backup and restore data.

Filling in the guest book which was usually done at the last graduation, is now being changed by presence via a QR Code. Before, The QR Code is distributed to each participant along with the distribution of invitations by email. On graduation day, the graduation participants showed their respective QR Codes to be read by the QR Code Reader owned by the committee, Figure 8.



Figure 8. Presensi peserta wisuda

MUGIS was used from the preparation for the graduation ceremony to graduation day. MUGIS has been proven to help to reduce committee workload, paper and printer ink efficiency, data transparency, support health protocols during the Corona pandemic (social distancing), easy to capture and distribution of data or information, monitoring of graduation participants (during registration and attendance) easily, can be accessed anytime and anywhere. This MUGIS played a very important role in the



success of the third graduation ceremony at Matana University.

IV. CONCLUSION

The Patas (Cepat Terbatas) software development model was built successfully. The implementation of the Patas model resulted in the Matana University Graduation Information System (MUGIS). The Patas model can be an alternative model for software development. To use the Patas model, an expert is needed, so that the selection of assistive devices and modifications runs smoothly. In the future, the Patas model needs to be tried for the development of different information systems or software.

REFERENCES

- [1] Barus, S. P. (2020). Design and Build a Seminar Management Information System to Manage 2019 Indonesian Qualitative Seminar & Workshop (SLKI). *International Journal of Informatics and Computation*, 2(1), 12. doi:10.35842/ijicom.v2i1.25
- [2] Inilah Wilayah PPKM di Jawa-Bali Periode 5 Hingga 18 Oktober 2021. (n.d.). Retrieved from <https://setkab.go.id/inilah-wilayah-ppkm-di-jawa-bali-periode-5-hingga-18-oktober-2021/>
- [3] Top 13 Software Development Models — Which is best? | Scopic. (2021, April 20). Retrieved from <https://scopicsoftware.com/blog/top-software-development-models/>
- [4] Budi, D. S., Siswa, T. A. Y., & Abijono, H. (2017). Analisis Pemilihan Penerapan Proyek Metodologi Pengembangan Rekayasa Perangkat Lunak. *Teknika*, 5(1), 24–31. doi:10.34148/teknika.v5i1.48
- [5] Barus, S. P., & Pangruruk, F. A. (2021). Penerapan Kerangka Kerja Scrum Pada Rancang Bangun Sistem Informasi Pelaporan Hasil Questioner Dosen Universitas Matana. *Ikraith-informatika*, 5(1), 68–73.
- [6] Arizal & Annisa Nurul Puteri. (2020). Sistem Informasi Manajemen Wisuda Berbasis Website Menggunakan Metode Waterfall. *Jurnal Sistem dan Informatika (JSI)*, 14(2), 125–134. doi:10.30864/jsi.v14i2.309
- [7] Sihotang, A. W. Y., & Wagiu, E. B. (2020). Perancangan Sistem Informasi Calon Wisudawan Universitas Advent Indonesia. *TeIKa*, 10(2), 125–133. doi:10.36342/teika.v10i2.2382
- [8] Anggoro, D., Sakti, D. V. S. Y., & Waluyo, S. (2021). Implementasi Sistem Informasi Berbasis QR Code Guna Mencegah Kerumunan dalam Antrian Wisuda. *Edumatic: Jurnal Pendidikan Informatika*, 5(1), 128–136. doi:10.29408/edumatic.v5i1.3383
- [9] Zhu, H., Xie, Y., Hou, M., Yan, K., Li, J., & Li, T. (2018). Research on a Digital Graduation Management System Based on the Internet. *Procedia Computer Science*, 131, 855–859. doi:10.1016/j.procs.2018.04.283
- [10] BAKTI - 6 Jenis Bahasa Pemrograman Terpopuler di Indonesia. (2019, October 11). Retrieved from https://www.baktikominfo.id/id/informasi/pengetahuan/6_jenis_bahasa_pemrograman_terpopuler_di_indonesia-1036
- [11] Bahasa Pemrograman yang Populer di Indonesia Tahun 2020. (2021, January 20). Retrieved from <https://suhu.co.id/berita/bahasa-pemrograman-yang-populer-di-indonesia-tahun-2020>
- [12] Devadiga, N. (2018). A Case Study on Identifying Software Development Lifecycle and Process Framework. *International Journal of Advanced Engineering Research and Science*, 5(7), 143–147. doi:10.22161/ijaers.5.7.21
- [13] GitHub - PHPMailer/PHPMailer: The classic email sending library for PHP. (n.d.). Retrieved from <https://github.com/PHPMailer/PHPMailer>
- [14] PHP QR Code. (n.d.). Retrieved from <https://sourceforge.net/projects/phpqrcode/>
- [15] Abdulloh, R. (2016). *Trik Mudah Membuat CMS Website dari Nol*. Jakarta: Elex Media Komputindo.
- [16] jQuery. (n.d.). Retrieved from <https://jquery.com/>
- [17] Bootstrap. (n.d.). Retrieved from <https://getbootstrap.com/>



Analysis Manipulation *Copy-Move* on Image Digital using SIFT Method and Histogram Color RGB

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Abstract – The application of the SIFT (Scale Invariant feature transform) algorithm and the RGB color histogram in Matlab can detect the suitability of objects in digital images and perform tests accurately. In this study, we discuss the implementation to obtain object compatibility on digital images that have been manipulated using the SIFT Algorithm method on the Matlab source, namely by comparing the original image with the manipulated image. The suitability of objects in digital images is obtained from the large number of keypoints obtained, other additional parameters, namely comparing the number of pixels in the analyzed image, as well as changes in the histogram in RGB color in each analyzed image. The purpose of this research is how to apply the SIFT (Scale Invariant feature transform) Algorithm and RGB color histogram to detect the suitability of objects in digital images and perform tests accurately. This study discusses the implementation to obtain object compatibility in digital images that have been manipulated using the SIFT Algorithm method on Matlab sources, namely by comparing the original image with the manipulated image. The application of the SIFT Algorithm (Scale Invariant Feature Transform) and RGB color histogram in determining the similarity of the keypoint location and the number of pixels in the image, to obtain object compatibility in digital images in matlab was successfully implemented and based on the test results obtained accuracy in identifying images in digital images.

Keywords – *Image Processing, Copy-Move, SIFT, Histogram RGB*

I. INTRODUCTION

Image processing on digital images can be easily created, edited and manipulated without leaving visual instructions by the user, such as gimp and adobe photoshop applications, for example, which makes it easy for the original image to be changed / manipulated. This ability can of course also be misused to damage the credibility of the authenticity of the image in various aspects, so that it can be carried out as a crime, image changes in digital images can convey information that is different from the image in the original digital image [1]. Criminals try to manipulate the image for their own benefit. The formation of an image in a digital image is obtained from several combinations of pixels [2]. To obtain a modified image, several stages are needed in carrying out a digital image forensics process. In it there are several changes from the original at each pixel value [3].

Digital technology, especially image, has become the main technology for creating, processing, transmitting and storing information in the form of knowledge and intellectual assets. Multidimensional knowledge and intellectual assets are produced and represented in various forms such as audio, video, text, images, if grouped, we can call it a multimedia form [4]. Finally, all forms are stored as digital form and byte form i.e., digital content. Image on Digital images are widely used in our society [5]. From newspapers to magazines, scientific journals, doctors in the medical field, the fashion industry, courtrooms and so on are very dependent on digital images [6]. Information integrity is fundamental in many fields. Digital technology is currently starting to erode trust. Although cases of photo\image tampering are not new, over the last few years, tampered images appear with frequency and sophistication, the development of increasingly sophisticated digital image

processing software, it has become easy to create image falsifications from one or more images without leaving clear clues [7]. Digital crime is growing at a very fast rate. This crime has caused many problems, including legal and ethical problems [8].

Image forgery in digital images is mostly done through a passive approach. One of the popular passive approaches is to manipulate by means of the copy-move technique [9]. Image falsification in digital images by means of an image being copied and then pasted into other parts of the image. Image copy-move forgery is done to hide certain details or to duplicate objects in an image. Because the forgery is done in one image, the damaged area is almost the same, the nature of the original image will be difficult to identify by humans [10].

With the field of digital image forensics, it will help law enforcement, intelligence, private investigations, and the media [11]. The increasingly advanced image technology at this time raises new issues and challenges in determining the authenticity of images in digital images. Digital image forensics is one of the scientific methods in the field of research that aims to obtain evidentiary facts in determining the authenticity of images in digital images [12]. This method Algorithm SIFT works by looking for a number of the same keypoint points that are suspected of having similar objects in the digital image, as well as calculating the number of pixels in the digital image.

This method can detect changes in scale, rotation and reflection, as well as changes in color enhancement on a digital image. [13].

SIFT (Scale Invariant Feature Transform) algorithm is an algorithm in computer vision to detect and describe local features in the image. This algorithm is patented in Canada by the University of British Columbia and published by David Lowe in 1999. This algorithm can perform object



recognition, robot mapping and navigation, image stitching, 3D modeling, gesture recognition, video tracking, identify wildlife [14]. In another study, the SIFT Algorithm (Scale Invariant Feature Transform) was used to match images based on the main keypoint features (scale invariant and rotation) [15]. The SIFT algorithm is one of the most widely used feature extraction methods. The Shift algorithm is used to find key points in the image, in this method it includes a shift description and a SIFT descriptor [16]. With so many crimes against image manipulation, it is hoped that the method that researchers use can analyze images in digital images so that they can detect images that have been changed from the original digital image [17].

Research on the multiple methods used in digital images has the following objectives:

1. Applying the SIFT (Scale Invariant Feature Transform) Algorithm and RGB color histogram using the Matlab application to be able to detect object matches in digital images.
2. Perform testing for better accuracy in analyzing images on digital images that have been changed from the original.

II. RESEARCH METHODOLOGY

A. Image Digital

Image is a representation (picture), likeness, or imitation of an object. The image is divided into 2, namely, there are images that are analog and there are images that are digital. Analog images are continuous images such as images on television monitors, X-ray photos, CT scan results, etc. Meanwhile, digital images are images that a computer can process.

A digital image can be represented by a matrix consisting of M columns and N rows, where the intersection between the columns and rows is called a pixel (pixel = picture element), which is the smallest element of an image. Pixels have two parameters, namely coordinates and intensity or color. The value contained in the (x,y) coordinate is $f(x,y)$, which is the intensity or color of the pixel at that point. Therefore, a digital image can be written in the following matrix form

$$f(x,y) = \begin{bmatrix} f(0,0) & f(0,1) & \dots & f(0,M-1) \\ f(1,0) & \dots & \dots & f(1,M-1) \\ \dots & \dots & \dots & \dots \\ f(N-1,0) & f(N-1,1) & \dots & f(N-1,M-1) \end{bmatrix}$$

Based on this description, mathematically a digital image can be written as a function of intensity $f(x,y)$, where x (row) and y (column) are position coordinates and $f(x,y)$ is the function value at each point (x, y) which represents the intensity of the image or the gray level or color of the pixels at that point. In the digitization process (sampling and quantity) the number of rows M and columns N is obtained so that the image forms matrix $M \times N$ and the number of gray levels of pixels is G.

B. Image Resolution

Image resolution is the level of detail of an image. The higher the resolution, the higher the detail level of the image. Each base color uses 8 bit = 1 byte storage, which

means that it has 255 color gradations, meaning that each pixel has as many color combinations. True color image storage in memory is different from grayscale images. Each pixel of a grayscale image has 256 color gradations represented by 1 byte. Meanwhile, 1 true color image pixel is represented by 3 bytes, each byte representing red, green, and blue.

C. Color image (24 bit)

Each pixel of a 24-bit color image is represented by 24 bits for a total of 16,777,216 color variations. This variation is more than enough to visualize all the colors that human vision can perceive. Human vision is believed to only be able to distinguish up to 10 million colors. Each pixel information point (RGB) is stored into 1 byte of data. The first 8 bits store the blue value, followed by the green value in the second 8 bits and the last 8 bits are red.

D. File Format Image

An image file format must be able to combine image quality, file size and compatibility with various applications. There are several types of standard image file formats used today. These formats are used to store images in a file. Each format has its own characteristics. These are examples of common formats, namely:Bitmap (.bmp), tagged image format (.tif, .tiff), PortablNetwork Graphics (.png), JPEG (.jpg), etc.

E. Algorithm SIFT (Scale Invariant feature transform)

Scale-invariant feature transform (SIFT) is an algorithm in computer vision to detect and describe local features in images. Applications of these algorithms include object recognition, robot mapping and navigation, 3D modeling, gesture recognition, video tracking, wildlife identification and similar image transfer.

III. RESULTS AND DISCUSSION

To do this test, the author uses the Matlab application, which has prepared the source code to detect the match of objects in digital images using the SIFT Algorithm. The following is a sample of the original image data and the manipulated image. The files have been processed using Photohop CC 2020, which are saved in JPG/JPEG format, the images include: ds_ori, ds_edit, cover, dika, agus_oci, three, girl1, girl2, cover, dian_ori, dian_edit, background, rs_ori, rs_edit, jm_ori, jm_edit, mnrp, ocy, oci_paris, oshi, sample, sample, rio, dn_edit, ds1, ds2, ar, etc. The SIFT Algorithm method used is a function that can read two images, find their SIFT features, and display a line connecting the matching keypoints. The equation obtained in the first image only if the distance is less than the ratio times the distance to the nearest equation in the second image, then returns the number of matches displayed. The way the algorithm works in this application is, after inputting two images, the initial stage is to find the keypoint on each image, the constant value is created at a ratio distance of 0.6, this is done with the hope, the way the analysis of matlab works becomes lighter, the descriptor in the first image, matched with the descriptor in the second image, the matrices in each image are recalculated, calculate the vector for each corner point, take the inverse cosine value and display the result, in addition to getting



the keypoint, another additional parameter is getting the pixel value to strengthen analysis of the studied image, the results of the process are presented in Table 1 below.

Table 1. Results of Matching Dian Sastro's Pair of Objects with the SIFT Algorithm and RGB Color Histogram

Image Asli 1	Image Asli 2	Image Manipulasi	Hasil Pencocokan Image
HISTOGRAM RGB :	HISTOGRAM RGB :	HISTOGRAM RGB :	Nilai Keypoint :
			Finding keypoints... 1218 keypoints found. Finding keypoints... 5149 keypoints found. Found 12 matches.
<p>Pada Perbandingan tiga image diatas menghasilkan nilai histogram dengan jumlah piksel yang berbeda - beda, artinya nilai histogram tersebut bisa dijadikan acuan sebagai parameter tambahan untuk melakukan pencocokan objek.</p>			<p>Ditemukan kecocokan objek sebanyak 12 keypoint pada perbandingan image yang dimanipulasi dengan yang asli</p>
Pada image berikut dilakukan pengujian kembali untuk kecocokan objek			
Finding keypoints... 1065 keypoints found. Finding keypoints... 1218 keypoints found. Found 0 matches.	Finding keypoints... 1027 keypoints found. Finding keypoints... 1218 keypoints found. Found 0 matches.	Finding keypoints... 524 keypoints found. Finding keypoints... 1218 keypoints found. Found 354 matches.	
Ditemukan 0 keypoint, artinya tidak ada kecocokan objek setelah mengambil sampel image pada wajah Dian Sastro yang lain	Ditemukan 0 keypoint, artinya tidak ada kecocokan objek setelah mengambil sampel image pada wajah Dian Sastro yang lain	Terdapat kecocokan objek pada wajah Dian Sastro sebanyak 354 kecocokan keypoint, setelah mengambil bagian dari wajah dian sastro yang asli.	

In comparison, the three images compared produce histogram values with different numbers of pixels, meaning that the histogram values can be used as a reference as an additional parameter to match objects, then when viewed from the number of keypoints, there are matches on objects marked with lines.

He use of the SIFT algorithm was chosen as the feature extraction method because this method is invariant to changes in scale, rotation, translation, and illumination. SIFT is used to obtain the characteristics of the obtained keypoint pattern. The hope is that by applying this method, from the keypoints obtained on each of these images, we get an accurate object match. The first step in determining the keypoint that is invariant to changes in the scale of the image is to find the extreme values in the scale space. To get the keypoint location in a scale space efficiently, the Difference-of-Gaussian (DoG) function is used, the value for the DoG function is obtained from the difference between Gaussian images with different scales.

Given orientation so that it will not be affected by the rotation of the image. In this study, the features in the form of keypoint locations and also the feature vectors of these keypoints have been obtained. Then the classification has been carried out, so it can be concluded that this system is able to detect the match of objects in digital images accurately. To strengthen the results of the analysis in the above test, additional tests using an RGB color histogram

graph (Red, Green, Blue) were also added. Where the level of difference in the image can be obtained from changes in the number of pixels and RGB colors displayed based on the histogram graph.

IV. CONCLUSION

The application of the SIFT (Scale Invariant Feature transform) algorithm and RGB color histogram in determining the similarity of keypoint locations and the number of pixels in the image, to obtain object compatibility in digital images in Matlab has been successfully implemented. Based on the test results obtained accuracy in identifying images in digital images using the SIFT Algorithm (Scale Invariant Feature Transform), that the research has been going well and smoothly.

REFERENCES

- [1] Koeshardianto, M. (2014). Pencocokan Obyek Wajah Menggunakan Metode Sift (Scale Invariant Feature Transform). *Nero*, 1(1), 53–59.
- [2] Setiyawan, A., & Basuki, R. S. (2014). Pencocokan Citra Berbasis Scale Invariant Feature Transform (SIFT) menggunakan Arc Cosinus. *Jurnal Teknik Informatika*, 1–4.
- [3] Amtullah, S., & Koul, D. A. (2014). Passive Image Forensic Method to detect Copy Move Forgery in Digital Images. *IOSR Journal of Computer Engineering*, 16(2), 96–104. <https://doi.org/10.9790/0661-1621296104>
- [4] Anh, N. T., Hang, H. T. T., & Chen, G. (2019). One approach in the time domain in detecting copy-move of speech recordings with the similar magnitude. *International Journal of Engineering and Applied Sciences (IJEAS)*, 6(4), 9–11. <https://doi.org/10.31873/ijeas/6.4.2019.05>
- [5] Mahalakshmi, D., & Science, C. (2017). Copy - Move Image Forgery Detection System Using Hybrid Method. *International Journal of Engineering Science Invention Research & Development*, III(XI), 692–698.
- [6] Inoue, K., Hara, K., & Urahama, K. (2017). RGB color cube-based histogram specification for hue-preserving color image enhancement. *Journal of Imaging*, 3(3). <https://doi.org/10.3390/jimaging3030024>
- [7] Korman, S., Reichman, D., Tsur, G., & Avidan, S. (2013). FasT-match: Fast affine template matching. *Proceedings of the IEEE Computer Society Conference on Computer Vision and Pattern Recognition*, 2331–2338. <https://doi.org/10.1109/CVPR.2013.302>
- [8] Salahat, E., & Qasaimah, M. (2017). Recent advances in features extraction and description algorithms: A comprehensive survey. *Proceedings of the IEEE International Conference on Industrial Technology*, 1059–1063. <https://doi.org/10.1109/ICIT.2017.7915508>
- [9] Dakhode, G., & Chourey, A. P. P. K. (2017). Forensic Technique for Detection of Image Forgery. *International Journal of Advanced Engineering*



- Research and Science*, 4(1), 189–193.
<https://doi.org/10.22161/ijaers.4.1.31>
- [10] Kashyap, A., Agarwal, M., & Gupta, H. (2018). Detection of copy-move image forgery using SVD and cuckoo search algorithm. *International Journal of Engineering and Technology(UAE)*, 7(2), 79–87.
<https://doi.org/10.14419/ijet.v7i2.13.11604>
- [11] Kresnha, P. E., Susilowati, E., & Adharani, Y. (2016). Pendeteksian Manipulasi Citra Berbasis Copy-move Forgery Menggunakan Euclidean Distance dengan Single Value Decomposition. *Seminar Nasional Teknologi Informasi Dan Multimedia 2016*, 6–7.
- [12] Wang, X. (2013). The research of digital recognition technology based on bp neural network. *BioTechnology: An Indian Journal*, 8(2), 180–185.
- [13] Ahmed, I. T., Hammad, B. T., & Jamil, N. (2021). A comparative analysis of image copy-move forgery detection algorithms based on hand and machine-crafted features. *Indonesian Journal of Electrical Engineering and Computer Science*, 22(2), 1177–1190.
<https://doi.org/10.11591/IJEECS.V22.I2.PP1177-1190>
- [14] Li, B., Ng, T. T., Li, X., Tan, S., & Huang, J. (2015). Revealing the trace of high-quality JPEG compression through quantization noise analysis. *IEEE Transactions on Information Forensics and Security*, 10(3), 558–573.
<https://doi.org/10.1109/TIFS.2015.2389148>
- [15] Xiang, Z., Bestagini, P., Tubaro, S., & Delp, E. J. (2022). *Forensic Analysis and Localization of Multiply Compressed MP3 Audio Using Transformers*. 2929–2933.
<https://doi.org/10.1109/icassp43922.2022.9747639>
- [16] Julliand, T., Nozick, V., Talbot, H., Julliand, T., Nozick, V., Talbot, H., Image, A., Detection, S., Julliand, T., Nozick, V., & Talbot, H. (2017). *Automated Image Splicing Detection from Noise Estimation in Raw Images To cite this version : HAL Id : hal-01510075 Automated Image Splicing Detection from Noise Estimation in Raw Images*.
- [17] Qiang, B., Chen, R., Zhou, M., Pang, Y., Zhai, Y., & Yang, M. (2020). Convolutional neural networks-based object detection algorithm by jointing semantic segmentation for images. *Sensors (Switzerland)*, 20(18), 1–14. <https://doi.org/10.3390/s20185080>



The Classification of Mushroom Types Using Naive Bayes and Principal Component Analysis

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Abstract. Indonesia is one of tropical countries with high humidity and makes it possible for various plants and microorganisms to grow properly. One of the microorganisms that can grow well in Indonesia is mushroom. They have several types including poisonous and edible mushrooms that can be consumed by human beings. There was a previous research on a classification of mushroom species using the Naive Bayes method with the title "Implementation of the Naive Bayes Classifier Method for Identification of Mushroom Types" and obtained pretty good accuracy results. This research conducted a classification using Naive Bayes which was improved by applying PCA as a dimension reduction technique to see the accuracy results obtained from improving this method. The dataset used is the Mushroom dataset from the official website of the UCI Machine Learning Repository. The Mushrooms dataset consists of 22 features and 1 class. After classification using Naive Bayes with Principal Component Analyst and evaluation using the 10-Fold Cross Validation technique, the results obtained are $pc = 10$ with an accuracy of 84%.

Keywords: *Dimension Reduction, Mushrooms Dataset, Principal Component Analyst*

I. INTRODUCTION

Indonesia is a tropical country which has high humidity and allows various plants and microorganisms to grow properly. One of the microorganisms that can grow well in Indonesia is mushroom [1].

Natural wealth and abundant biodiversity in a country is something to be grateful for. One of these natural wealth that we know is mushrooms. In subtropical areas with cold temperatures to tropical areas with warm temperatures there have been more than thousands of mushrooms with various types. Several types of mushrooms scattered in the world considerably can cause disease in humans and plants, which even some of them are contain toxins [2].

In agriculture, the applicable case of classification is determining whether the species of oyster mushroom (gilled mushroom) from the Agaricus and Lepiota families are either classified as poisonous or safe for consumption [3]. The importance of classifying a mushroom to be a topic in this research is to determine whether a mushroom is either classified as poisonous class or safe for consumption based on the physical characteristics of the features themselves.

This identification is very important because the process of retrieving a plant species in data storage is considered difficult and requires quite a long time to go [4].

There have been many researches on the classification of mushrooms using computer equipment and data mining methods. Research that has been done previously was classification using Naive Bayes algorithm for the Mushroom dataset from the UCI Machine Learning Repository with the title "Implementation of the Naive Bayes Classifier Method for Identifying Mushroom Types" by Septian Ari Prayoga, Ismasari Nawangsih, and Tri Ngudi Wiyatno. From the results of the classification process, it can be concluded that the accuracy using Naive Bayes method is 86.06%, and classified into good classification. Shows that the naive Bayes classifier method is well applied in the identification of agaricus and lepiota mushrooms in the edible or poisonous category [5].

Based on the results of previous research, researchers wanted to conduct research on the classification of mushroom species using Naive Bayes and improved by applying dimension reduction techniques using Principal Component Analysts. The purpose of improving this method is

to see the results of the accuracy obtained from the application of the dimensional reduction technique used.

II. RESEARCH METHOD

In this research, there are several systematic stages are implied, as shown in the picture below.

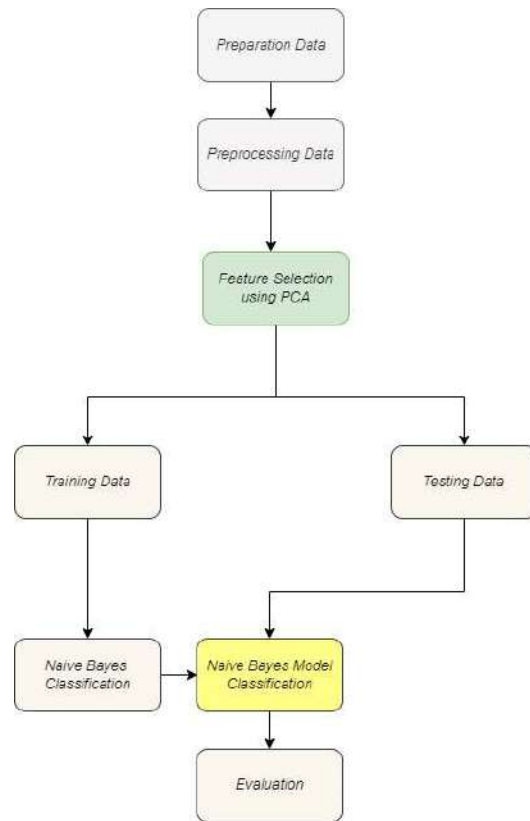


Image 1. Research methodology scheme.

The dataset was obtained from the official UCI Machine Learning Repository website. The data used is called Mushroom Data Set. The purpose of this data collection is to distinguish between edible and poisonous mushrooms using the Naïve Bayes classification technique and the Principal Component Analyst using mushroom data, and to determine the level of accuracy.

2.1 Data Preparation

The dataset used is a mushroom dataset of 8124 records with large dimensions of 22 attributes and 1 class.

Table 1. Mushroom Data Variables

Variables	Attributes Information
cap-shape	bell=b,conical=c,convex=x,flat=f, knobbed=k,sunken=s
cap-surface	fibrous=f,grooves=g,scaly=y,smooth=s
cap-color	brown=n, buff=b, cinnamon=c, gray=g, green=r, pink=p, purple=u, red=e, white=w, yellow=y

bruises	bruises=t,no=f
odor	almond=a,anise=l,creosote=c,fishy=y,foul=f, musty=m,none=n,pungent=p,spicy=s
gill-attachment	attached=a,descending=d,free=f,notched=n
gill-spacing	close=c,crowded=w,distant=d
gill-size	broad=b,narrow=n
gill-color	black=k,brown=n,buff=b

	,chocolate=h,gray=g, green=r,orange=o,pink= p,purple=u,red=e, white=w,yellow=y
stalk-shape	enlarging=e,tapering=t
stalk-root	bulbous=b,club=c,cup= u,equal=e, rhizomorphs=z,rooted=r ,missing=?
stalk-surface-above- ring	fibrous=f,scaly=y,silky= k,smooth=s
stalk-surface-below- ring	fibrous=f,scaly=y,silky= k,smooth=s
stalk-color-above- ring	brown=n,buff=b,cinnam on=c,gray=g,orange=o, pink=p,red=e,white=w,y ellow=y
stalk-color-below- ring	brown=n,buff=b,cinnam on=c,gray=g,orange=o, pink=p,red=e,white=w,y ellow=y
veil-type	partial=p,universal=u
veil-color	brown=n,orange=o,whit e=w,yellow=y
ring-number	none=n,one=o,two=t
ring-type	cobwebby=c,evanescent =e,flaring=f,large=l, none=n,pendant=p,sheat hing=s,zone=z
spore-print-color	black=k,brown=n,buff=b ,chocolate=h,green=r, orange=o,purple=u,whit e=w,yellow=y
population	abundant=a,clustered=c, numerous=n, scattered=s,several=v,so litary=y
habitat	grasses=g,leaves=l,mea dows=m,paths=p, urban=u,waste=w,woods =d

2.2 Preprocessing Data

Pre-processing is a stage that is carried out on a set of data that will be used as training data before the mining process, both for classification and clustering [6]. The preprocessing stages carried out in this research used the process of cleansing and transforming data [7].

2.3 K-fold Cross Validation

The technique of cross validation is k-fold cross validation, which breaks the data into 'k' parts of the data set with the same size. The use of k-fold cross validation is to eliminate bias in the data. Training data and data testing are carried out as many as the specified number of k [8].

In k-fold cross validation, the original data is partitioned into subsets. This model then build by using data from subnet K-1 (2,3,4,5, etc.), and any other part of the subset used for the test set. The subset (dataset) itself should be more than just a test set, carried out iteratively to have a different model. The results of each K model (accuracy) are then combined by using an average to obtain accuracy results from the entire data. The benefit of using k-fold cross-validation is that each record can be recorded as once of a time, therefore, the disadvantage is that the validation task needed tends to be more difficult in progres [9]. Whereas the steps are as follow :

- Dataset being used is the mushroom around of 8124 records are already processed at the preprocessing, so the data shall be ready to process further.
- The distribution of data training and data testing or usually be called as Split, which is using the 10-fold cross validation method, the dataset will be divided into 10 parts from 8124 on category edible and poisonous mushrooms.

2.4 Dimension Reduction

At this stage, feature reduction is performed on the mushroom dataset using the Principal Component Analyst. Dimensional reduction is the process of reducing the number of features (dimensions) without eliminating important information from the data. Usually dimension reduction is applied as a preprocessing method to create a better classification model [10]. Principal Component Analysis (PCA) is

a technique that used for the pre-processing process to perform feature scaling and data reduction [11]. The Principal Component Analysis (PCA) method is very useful for data that has a large number of features and has a correlation (interconnected) between the variables. The calculation of the principal component analysis (PCA) is based on the calculation of the eigenvalues and eigenvectors which express the distribution of data from a dataset [12].

The reduction function is used to reduce the number of variables (which were initially very large) to be smaller so as to facilitate analysis at a later stage. Meanwhile, the transformation function is used to change variables that are initially correlated to be uncorrelated. The following are the steps needed to perform Principal Component Analysis, as such:

1. Preparing data (data standardization),
2. Calculate the covariance matrix or correlation matrix,
3. Calculating the eigenvalues and eigenvectors from the correlation matrix,
4. Choose the principal component,
5. Output visualization,
6. Calculates a new score.

2.5 Naive Bayes Classification

At this stage, the classification model is made using Naive Bayes algorithm with the following stages [5].

1. Training is the determination of data that will be used as input for testing using the Naive Bayes method.
2. Classification is carried out for data testing and data training.
3. Accuracy. At this stage, accuracy calculations will be carried out using rapid miner tools on each test based on the confusion matrix of each test.

One of the probabilistic classification algorithms, the naive Bayes algorithm is a simple probabilistic classification based on the application of the Bayes theorem with strong assumption of independence, in other words the Naive Bayes algorithm assumes that the existence of a certain value of an attribute is not related to the presence of other attribute values. Naive Bayes classification is very suitable when the input dimensions are high, and has comparable performance with several other classification methods such as decision trees and neural network classifiers. Here are the equation of the theory of Naive Bayes:

$$p(D) = \frac{p(D)p(H)}{p(D)} \quad (1)$$

Where :

P : Probability

D : Data with an unknown class.

H : The data hypothesis is class specific.

$p(\square|\square)$: Hypothesis H probability based on condition D (posterior probability).

$p(\square)$: Hypothesis H probability (prior probability).

$p(\square|\square)$: Probability D is based on the conditions in hypothesis H.

$p(\square)$: D probability.

2.6 Confusion Matrix

Evaluation to measure the performance of the model is using confusion matrix. Where the confusion matrix is obtained from the validation process. Evaluating the performance of classification algorithms generally uses the overall results on the test dataset. A matrix of predictions that will be compared with the original class of input or in other words contains information on the actual and predicted values of the classification [13]. Confusion matrix can help show the details of classifier performance by providing information on the number of features of a class that are correctly and incorrectly classified [14]. Confusion matrix is a table that represents the performance of an algorithm or model specifically as shown in Table X [15].

4. True Positive = the number of actual data with positive class and prediction of the positive model.
5. True Negative = the number of actual data with negative class and the prediction of the negative model.
6. False Positive = the number of actual data with a negative class and the predictions of the positive model.
7. False Negative = the number of actual data with a positive class and the predictions of the negative model.

Based on the data above there are other data that can be used to measure the model performance, namely :

1. Accuracy = the total of all data that correctly classifies.
 $(TP + TN) / \text{Total}$
2. Precision = The total of all correct data with positive predictions.
 $TP / (FP + TP)$

3. Recall = The total of how often the model produces positive predictions with the actual positive class.
 $TP / (FN + TP)$
4. F1-Score = average harmonics of Precision and Recall
 $2 \times ((precision \times recall) / (precision + recall))$

2.7 Evaluation

At this stage, validate the model obtained by using k-Fold Cross Validation. Cross-validation (CV) is a statistical method that can be used to evaluate the performance of a model or algorithm where the data is separated into two subsets, namely learning process data and validation / evaluation data. The model or algorithm is trained by the learning subset and validated by the validation subset. Furthermore, the selection of the type of CV can be based on the size of the dataset. Usually CV K-fold is used because it can reduce computation time while maintaining the accuracy of the estimate.

III. RESULTS AND DISCUSSION

3.1 Pre-Processing

At this preprocessing stage, the missing value is replaced in the stalk-root variable with the mean value and the data is normalized.

- a. Replacing the missing value in the stalk-root variable with the mean value
In the mushroom dataset there are 2840 missing value on the stalk-root variable and 5644 valid data. the value in the missing value "?" need to replace the value of "?" becomes "nan" and then deletes every row that has the value "nan". This process is to get the mean value. determining the value of mean value, the first thing to do is replace the value of "?" with nan then delete the row contain the value nan. After replacing the value on the missing value, a new value is obtained as shown in the following image. 5644 rows are obtained as shown in the image below.

Table 2. removing missing values

After obtaining a new value, the categorical data is converted into numerical data as shown in the image below.

Then change the categorical data to be numerical data, as it shown in the following image below.

Table 3. Numerical data

Then for the second stage, which is to calculating the mean on the stalk-root variable. The mean value obtained is 1.59 which is then rounded in integer form to 2. In the stalk-root variable, the value of 2 is the value for c or it can be called CLUB.

```
Mengubah hasil pembulatan dari numerik ke kategorik

[14] unique_stalk_root = data_drop['stalk-root'].unique()
sort_stalk_root = sorted(unique_stalk_root)

sort_stalk_root[round_stalk_root-1]

'c'
```

Image 2. Rounding results from numeric to categorical.

After the c or CLUB value is obtained, then the missing value will be filled in by using the categorical attribute value. Then after that, it is being converted from the categorical data into numerical data.

Tabel 4. Data Categorical

Table 5. Numerical Data

- b. Data normalization
The numerical data from the previous process is then being normalized by using min-max normalization method.




```
array([[1.0, 0.66666667, 0.44444444, ..., 0.25, 0.6,
0.83333333],
[1.0, 0.66666667, 1.0, ..., 0.375, 0.4,
0.16666667],
[0.5, 0.66666667, 0.88888889, ..., 0.375, 0.4,
0.5],
...,
[0.4, 0.66666667, 0.44444444, ..., 0.0, 0.2,
0.33333333],
[0.6, 1.0, 0.44444444, ..., 0.875, 0.8,
0.33333333],
[1.0, 0.66666667, 0.44444444, ..., 0.5, 0.2,
0.33333333]])
```

Image 3. Data Normalization

3.2 Principal Component Analyst

After the pre-processing stage, a classification process will be carried out using Naive Bayes. before starting the classification process, the mushroom dataset is divided into training data and testing data with 90% for training data and 10% for testing data. In the classification process this test uses 10-fold cross validation and the number of pc = 10. The following is a visualization of the number of principal components.

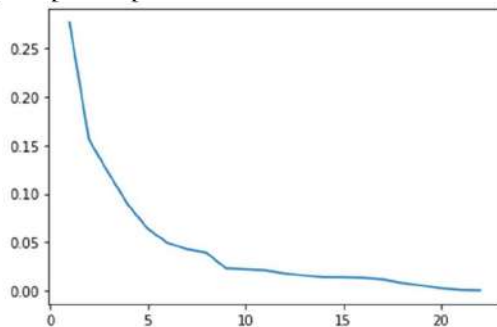


Image 4. Schematic of research methodology.

The results of this research were obtained from the calculation of the correlation matrix and feature selection using PCA with 10 components, the accuracy results is 84%

```
[ ] pca = PCA(n_components=10)
principalComponents = pca.fit_transform(X)
variance_ratio = pca.explained_variance_ratio_

clf = GaussianNB()

scores = cross_val_score(clf, principalComponents, y.ravel(), cv=10)
print("Accuracy: %.2f" % (scores.mean()))

Accuracy: 0.84
```

Image 5. Program calculation results.

3.3 Confusion Matrix

In this research, after classifying the mushroom data based on data sharing using K-fold Cross Validation method, 90% of the training data and 10% of the testing data of the entire data were random and balanced. In order to obtain 8124 data as test data which is evaluated by looking at the information contained regarding the classification which is

correctly predicted by a classification system in the confusion matrix

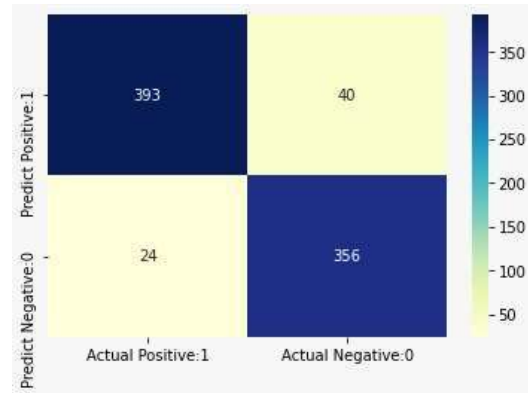


Image 6. Confusion Matrix

Based on the results of the confusion matrix, precision and recall values can be calculated manually as follows :

Precision value

$$\text{Precision} = \frac{TN}{(TP+FP)} = \frac{356}{(393+40)} = 0.8221$$

Recall value

$$\text{Recall} = \frac{TP}{(TP+FN)} = \frac{393}{(393+24)} = 0.9424$$

IV. CONCLUSION

Based on the results of this research, to determine the types of edible mushrooms and poisonous mushrooms using Naive Bayes classification method and applying the Principal Component Analyst with the number of pc = 10 and applying the evaluation technique using 10-Fold Cross Validation the accuracy value is 84%. so that it can be concluded that the Naive Bayes algorithm method using principal component analyst is good enough to be applied in classifying the types of poisonous and edible mushrooms.

REFERENCES

[1] Fitriani, L., Krisnawati, Y., Anorda, M. O. R., & Lanjarini, K. (2018). JENIS-JENIS DAN POTENSI JAMUR MAKROSKOPIS YANG TERDAPAT DI PT PERKEBUNAN HASIL MUSI LESTARI DAN PT DJUANDA SAWIT KABUPATEN MUSI RAWAS. *Jurnal Biosilampari: Jurnal Biologi*. <https://doi.org/10.31540/biosilampari.v1i1.49>

[2] Parjimo, H., & Andoko, A. (2007). *Budi Daya Jamur (Jamur Kuping, Jamur Tiram, Jamur Merang)*.

[3] Prihatini, R. (n.d.). Penerapan Data Mining



sebagai Evaluasi Ketepatan Akurasi terhadap Klasifikasi Mushroom Data Set. *Academia.Edu*, 11.

[4] Aruan, T. (2017). *IDENTIFIKASI JENIS TANAMAN JAMUR BERACUN MENGGUNAKAN PENDEKATAN K-NEAREST NEIGHBOR*.

[5] Prayoga, Septian Arie, I. N. and T. N. W. (2019). Implementasi Metode Naive Bayes Classifier Untuk Identifikasi Jenis Jamur. *Ilmiah Informatika, Arsitektur Dan Lingkungan*, 14(2), 134–144. <https://jurnal.pelitabangsa.ac.id/index.php/pelitatekno/article/view/239/191>

[6] Misra, P., & Yadav, A. S. (2019). Impact of Preprocessing Methods on Healthcare Predictions. *SSRN Electronic Journal*, *MI*. <https://doi.org/10.2139/ssrn.3349586>

[7] Muttaqin, F. A., & Bachtiar, A. M. (n.d.). *IMPLEMENTASI TEKS MINING PADA APLIKASI PENGAWASAN PENGGUNAAN INTERNET ANAK " DODO KIDS BROWSER "* *Jurnal Ilmiah Komputer dan Informatika (KOMPUTA) Jurnal Ilmiah Komputer dan Informatika (KOMPUTA)*.

[8] Tuntun, R. (2022). *Analisis Perbandingan Kinerja Algoritma Klasifikasi dengan Menggunakan Metode K-Fold Cross Validation*. 6, 2111–2119. <https://doi.org/10.30865/mib.v6i4.4681>

[9] Larose, D. T., & Larose, C. D. (2014). *Discovering Knowledge in Data: An Introduction to Data Mining: Second Edition*. In *Discovering Knowledge in Data: An Introduction to Data Mining: Second Edition*. <https://doi.org/10.1002/9781118874059>

[10] Hedyati, D., & Suartana, I. M. (2021). Penerapan Principal Component Analysis (PCA) Untuk Reduksi Dimensi Pada Proses Clustering Data Produksi Pertanian Di Kabupaten Bojonegoro. *Journal of Information Engineering and Educational Technology*. <https://doi.org/10.26740/jieet.v5n2.p49-54>

[11] Sartika, D., & Saluza, I. (2022). Penerapan Metode Principal Component Analysis (PCA) Pada Klasifikasi Status Kredit Nasabah Bank Sumsel Babel Cabang KM 12 Palembang Menggunakan Metode Decision Tree. *Generic*, 14(2), 45–49.

[12] Nasution, M. Z., Nababan, A. A., & Syaliman, K. U. (2019). *PENERAPAN PRINCIPAL COMPONENT ANALYSIS (PCA) DALAM*

PENENTUAN FAKTOR DOMINAN YANG MEMPENGARUHI PENGIDAP KANKER SERVIKS (Studi Kasus : Cervical Cancer Dataset). 3(1), 204–210.

[13] Telaumbanua, K., Sudarto, S., Butar-Butar, F., & Bilqis, P. S. (2021). Identifikasi Sampah Berdasarkan Tekstur Dengan Metode GLCM dan GLRLM Menggunakan Improved KNN. *Explorer*. <https://doi.org/10.47065/explorer.v1i2.94>

[14] Bramer, M. (2016). *Introduction to Data Mining*. https://doi.org/10.1007/978-1-4471-7307-6_1

[15] Saputro, I. W., & Sari, B. W. (2020). Uji Performa Algoritma Naive Bayes untuk Prediksi Masa Studi Mahasiswa. *Creative Information Technology Journal*. <https://doi.org/10.24076/citec.2019v6i1.178>

Multi Attribute Utility Theory (MAUT) Method of Decision on The Selection of the Head of Study Program Digital Business

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Abstract– The head of the study program is the spearhead of success in a study program. So a head of a study program is required to have good leadership and management skills in order to be able to carry out his duties and functions correctly. The problem that arises is that the appointment of a head of a study program is often carried out not looking at some aspects or criteria, usually the appointment is subjective and based on how long he has been a lecturer in the study program. Even though the appointment of a study program head must be seen from many aspects and criteria, this is done because if you appoint a study program head who is not competent, it can result in not running well with the study program he leads. The criteria used in this research are Functional Position, Education, Working Period, Research, PKM Activities, Supporting Activities and Lecturer Achievement. To overcome this problem, a decision support system with the MAUT method is the right solution to use. The advantage of the MAUT method is that the calculation and decision-making process is faster because it can directly calculate the final evaluation value without the need to compare the importance weight values between criteria. This method will process the criteria values of each candidate so that the results will be more objective. In this study, the number of alternatives used was 6 data on the value of the prospective head of the study program. Based on the MAUT process, a decision was obtained that the chosen head of the digital business study program was a Candidate-01 lecturer with a value of 1.0.

Keywords – Decision Support System, MAUT, Head of Program Study

I. INTRODUCTION

The use of technology as a reference in a decision decisions are not foreign for a company or organization, because technology in various fields at this time is very advanced very rapidly both in terms of speed and convenience[1]. Examples of the application of technology such as in the field of health[2], the field of agriculture (Wendra et al., 2020), the field of management[4], the field of Education [5], the field of environment[6] and many other applications.

Apart from the development of technology, various branches of technology have also emerged, such as expert systems[7], fuzzy systems[8], robotics[9], decision support systems [10], forecasting systems[11] and many other branches of technological science. In this study, the branch of technology applied is a decision support system, which in general can be interpreted as a computer-based system that can help decision making to solve certain problems[12].

The application of decision support systems is often applied to problems of a certain nature in their nature selection and is often also faced with complex decision alternatives as well as requires expert opinion. The application of DSS includes the selection of employees who are entitled to get rewards [13], the selection of the best state civil apparatus, with the results a system that is built only as a tool to provide information to the leadership as a consideration in making decisions[14], then for the selection of the best interns with the final result of the system built provides a sequence of employee assessments from the highest to the lowest based on the criteria used by

the company[15]. In the decision support system, knowledge can be embedded in the form of algorithms or methods that function as data processing inputted by users who want to make decisions. These methods include the topsis method[16], the SAW method[17], the AHP method[18] and many more decision support system methods others. In this study, the method used was multi attribute utility theory (MAUT).

Where the MAUT method is a method that consists of several attributes (multi discrete criteria) the decision to create a model that prioritizes existing alternatives, while giving a relative weight called MAUT weight[19]. The Multi-Attribute Utility Theory (MAUT) approach is a quantitative comparison method that usually combines the measurement of various risks and costs of benefits. There are several alternatives for each of the existing criteria, which can provide solutions. The advantage of the MAUT method is that the calculation and decision-making process is faster because it can directly calculate the final evaluation value without the need to compare the importance weight values between criteria. The selection of this method is because it has been applied to decision making both in the organization and in solving non-organizational problems. The application of the MAUT method in this study is for the selection of the head of the digital business study program .

In the context of the world of education, the existence of leaders is important to carry out the work programs of educational institutions, especially in carrying out control over the work programs of these educational institutions[20]. The head of the study program is the spearhead of the success of a study program. So a head of



a study program is required to have good leadership and management skills in order to be able to carry out his duties and functions properly. The head of the study program is a strategic position within the college, which is responsible for the back and forth of an education department at the college. This position serves to lead the implementation of education, research, community service, cooperation and fostering the academic community and administrative personnel within the study program [21].

The problem that arises is that the appointment of a head of a study program is often carried out not looking at some aspects or criteria, usually the appointment is subjective and based on how long it takes has been a lecturer in the study program. Even though the appointment of a study program head must be seen from many aspects and criteria, this is done because if you appoint a study program head who is not competent, you can resulting in not running well the study program he led.

Based on this, through this research, solutions will be offered as consideration for decision makers. The solution offered is to build a system that is able to provide decision recommendations to the head of the study program with the MAUT method, this method will provide the best decision based on the value of each prospective head of the study program.

II. RESEARCH METHODOLOGY

The research framework is the order that will be carried out in a study. So that the steps taken by the author in this design do not deviate from the subject matter and are easier to understand, the sequence of research steps will be made systematically so that it can be used as a clear and easy guide to solve existing problems. The sequence of steps to be made in this study can be seen in the following figure:

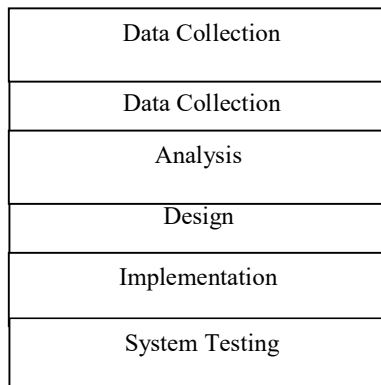


Figure 1. Research Framework

Stages of Research

Research (*research*) is a scientific activity to find, develop and test the truth of a knowledge or problem in order to find a solution to a problem. In general, the data obtained from research can be used to understand, solve, and anticipate a problem. The function of the research is to find explanations and answers to problems and provide alternatives to possibilities that can be used for problem solving. The solution and answer to the problem can be abstract and general as is the case in basic research (*basic*

reaserch) and can be specific as is usually found in *applied research* (*applied reasearch*).

In conducting research, a method is needed to conduct such research. Research methods are a series of ways / activities of conducting research according to scientific steps that are arranged systematically and logically so that they can be used as clear and easy guidelines to solve a problem. Each stage is an interrelated part to determine the process at the next stage.

Preliminary Research

Preliminary Research is the first step in conducting a study by first analyzing the problems to be developed. Problems regarding the symptoms of autistic disease that are not well known by the public and solutions and actions that must be taken to be able to overcome autistic diseases earlier so that it is not too late to be treated. This research was conducted by conducting interviews. This study aims to help users in recognizing the symptoms of autistic disorders and can also provide information to users in overcoming the problem of autistic disorders early on.

Data Collection

Data collection is the second stage after preliminary research is carried out which contains sequences from the beginning to the end of the study. In conducting research, to obtain information about the object of study, a data collection stage is needed,

Analysis

In this stage, it can be done with three stages of analysis as follows:

1. Data Analysis
The data obtained from the interview results will then be analyzed so that a set of rules (*rulebase*) will be obtained that will be associated with facts (*input data*) using the MAUT method that has been applied to the system so that the system can provide the right decision.
2. Process Analysis
At this stage of process analysis, the author uses the MAUT method, where this system can help users in resolving uncertainty. Uncertain outcomes are caused by two things: uncertain rules and uncertain user answers or a question asked by an expert system.
3. System Analysis
At the analysis stage, this system is carried out to design and build a system that will be made using the MAUT method. These design and development include, designing user views, designing databases for the system so that existing file management is more organized, and designing coding programs from information. Where the program will be created using PHP and MySQL languages. From these stages, an expert system is formed that can be used

Design

At this stage there are two types of design that will be carried out including:

1. Model Designing
The processes carried out in this design resistance are to collect data and facts that support the design of the system by consulting with experts.



Furthermore, a comparison stage is carried out between the results of expert research and those in books and other references. At this stage, UML (*Unified Modeling Language*) is used which is a data logic model created to describe where the data comes from, where the data that comes out of the system, where the data is stored, what processes produce the data, the interaction between the stored data and the processes imposed on the data.

2. *Interface Design*

Interface design or interface design is a form of temporary display design from the creation of this expert system application. This design was created to provide an explanation of the appearance faced by actors when using the system, so that it can make it easier to implement applications and will facilitate the construction of applications that meet the principles of good interface design.

Implementation

System implementation is part of the system development life cycle. at this stage, an expert system application specifically for autistic diseases will be designed using PHP and MySQL programming languages to create a website and database that will store data on the symptoms of autistic diseases by applying the *Dempster-Shafer method*.

Testing

System testing is a stage of *testing* to find out errors in the system. one of the important things in the expert system is being able to consult computerized and find out the errors that occur in the system. testing this system will be carried out by testing the LAN and *Online networks*.

III. RESULTS AND DISCUSSION

Data Analysis

The data analysis process is one of the important stages in this study, because at this stage, identification of the problems that exist in the assessment of lecturer performance at STMIK GICI will be carried out.

Problem analysis is carried out so that the findings of the problems obtained can be known the cause, so that from the analysis of the problem, a form of problem solving is obtained. Problem solving is a way that can solve the problems that have been described in the problem analysis above is to build a support system for the selection of the head of the digital business study program.

Process Analysis With MAUT

MAUT method is a method consisting of several attributes (multi discrete criteria) of decisions to create a model that prioritizes existing alternatives, while giving it a relative weight called a weighted MAUT. Here are some stages of applying the MAUT[19].

The procedure for selecting the head of the digital business study program Using the MAUT Method will be explained in the order of how the procedure is, the author uses data samples and alternative data based on data obtained from field studies. Where the data amounts to 8 alternative and 7 criteria. To determine the value of each

criterion the author collected data in the previous year and had interviews directly with the high school. The criteria used are as follows:

- K1 = Functional Position
 - a. Head Lector = 5
 - b. Lector = 4
 - c. Expert Assistants = 3
 - d. NJFA = 2
- K2 = Education
 - a. S3 = 5
 - b. S2 = 4
- K3 = Service Life
 - a. >=5 years =5
 - b. <5 years = 3
- K4 = Research
 - a. >=10=5
 - b. 8 – 9 = 4
 - c. 6 – 7 = 3
 - d. <=6=2
- K5 = PKM Activities
 - a. Ada = 5
 - b. None = 2
- K6 = Supporting Activities
 - a. Ada = 5
 - b. None = 2
- K7 = Lecturer Achievement
 - a. Ada = 5
 - b. None = 2

Furthermore, the determination of the weight of each grade contained in the student will be carried out as follows:

Table 1. Weighting Criteria

Code	Weight
K1	0.25
K2	0.20
K3	0.15
K4	0.10
K5	0.10
K6	0.10
K7	0.10

After the indicator value is known, the assessment data obtained will be used as follows:

Table 2. Lecturer Value Data

NO	Lecturer	K1	K2	K3	K4	K5	K6	K7
1	Nominee-01	4	5	5	5	5	5	5
2	Nominee-02	4	5	5	5	5	5	2
3	Nominee-03	3	5	3	4	2	5	2
4	Nominee-04	3	4	5	5	2	5	5
5	Nominee-05	4	4	2	5	2	5	5
6	Nominee-06	4	5	2	2	5	2	5
7	Nominee-07	3	5	3	4	2	5	2
8	Nominee-08	4	5	2	2	5	2	5

The normalization of the matrix is determined by the formula:

$$U_{(x)} = \frac{X - X_i^-}{X_i^+ - X_i^-}$$

X = Alternate weight

X_i^- = Worst weight (minimum) of the Xth criterion

X_i^+ = Best weight (maximum) of the Xth criterion

The following is the calculation of the normalization matrix:



a. **Normalization of Candidates-01 (A1)**

$$A1_1 = \frac{4-3}{4-3} = \frac{1}{1} = 1$$

$$A1_2 = \frac{5-4}{5-4} = \frac{1}{1} = 1$$

$$A1_3 = \frac{5-2}{5-2} = \frac{3}{3} = 1$$

$$A1_4 = \frac{5-2}{5-2} = \frac{3}{3} = 1$$

$$A1_5 = \frac{5-2}{5-2} = \frac{3}{3} = 1$$

$$A1_6 = \frac{5-3}{5-2} = \frac{3}{3} = 1$$

$$A1_7 = \frac{5-2}{5-2} = \frac{3}{3} = 1$$

b. **Normalization of Candidates-02 (A2)**

$$A2_1 = \frac{4-3}{4-3} = \frac{1}{1} = 1$$

$$A2_2 = \frac{5-4}{5-4} = \frac{1}{1} = 1$$

$$A2_3 = \frac{5-2}{5-2} = \frac{3}{3} = 1$$

$$A2_4 = \frac{5-2}{5-2} = \frac{3}{3} = 1$$

$$A2_5 = \frac{5-2}{5-2} = \frac{3}{3} = 1$$

$$A2_6 = \frac{5-3}{2-2} = \frac{3}{0} = 1$$

$$A2_7 = \frac{5-2}{5-2} = \frac{3}{3} = 0$$

c. **Normalization of Candidates-03 (A3)**

$$A3_1 = \frac{3-3}{4-3} = \frac{0}{1} = 0$$

$$A3_2 = \frac{5-4}{3-2} = \frac{1}{1} = 1$$

$$A3_3 = \frac{5-2}{4-2} = \frac{3}{2} = 0,33$$

$$A3_4 = \frac{5-2}{2-2} = \frac{3}{0} = 0,67$$

$$A3_5 = \frac{5-2}{5-2} = \frac{3}{3} = 0$$

$$A3_6 = \frac{5-3}{2-2} = \frac{3}{0} = 1$$

$$A3_7 = \frac{5-2}{5-2} = \frac{3}{3} = 0$$

d. **Normalization of Candidates-04 (A4)**

$$A4_1 = \frac{3-3}{4-3} = \frac{0}{1} = 0$$

$$A4_2 = \frac{4-4}{4-4} = \frac{0}{0} = 0$$

$$A4_3 = \frac{5-4}{5-2} = \frac{1}{3} = 1$$

$$A4_4 = \frac{5-2}{5-2} = \frac{3}{3} = 1$$

$$A4_5 = \frac{5-2}{2-2} = \frac{3}{0} = 0$$

$$A4_6 = \frac{5-3}{5-2} = \frac{3}{3} = 1$$

$$A4_7 = \frac{5-2}{5-2} = \frac{3}{3} = 1$$

e. **Normalization of Candidates-05 (A5)**

$$A5_1 = \frac{4-3}{4-3} = \frac{1}{1} = 1$$

$$A5_2 = \frac{5-4}{4-4} = \frac{1}{0} = 0$$

$$A5_3 = \frac{5-2}{2-2} = \frac{3}{0} = 0$$

$$A5_4 = \frac{5-2}{5-2} = \frac{3}{3} = 1$$

$$A5_5 = \frac{5-2}{5-2} = \frac{3}{3} = 0$$

$$A5_6 = \frac{5-3}{5-2} = \frac{3}{3} = 1$$

$$A5_7 = \frac{5-2}{5-2} = \frac{3}{3} = 1$$

f. **Normalization candidate-06 (A 6)**

$$A6_1 = \frac{4-3}{4-3} = \frac{1}{1} = 1$$

$$A6_2 = \frac{5-4}{5-4} = \frac{1}{1} = 1$$

$$A6_3 = \frac{5-2}{2-2} = \frac{3}{0} = 0$$

$$A6_4 = \frac{5-2}{5-2} = \frac{3}{3} = 0$$

$$A6_5 = \frac{5-2}{2-2} = \frac{3}{0} = 1$$

$$A6_6 = \frac{5-3}{5-2} = \frac{3}{3} = 0$$

$$A6_7 = \frac{5-2}{5-2} = \frac{3}{3} = 1$$

g. **Normalization of Candidates-07 (A7)**

$$A7_1 = \frac{3-3}{4-3} = \frac{0}{1} = 0$$

$$A7_2 = \frac{5-4}{3-2} = \frac{1}{1} = 1$$

$$A7_3 = \frac{5-2}{4-2} = \frac{3}{2} = 0,33$$

$$A7_4 = \frac{5-2}{2-2} = \frac{3}{0} = 0,67$$

$$A7_5 = \frac{5-2}{5-2} = \frac{3}{3} = 0$$

$$A7_6 = \frac{5-3}{2-2} = \frac{3}{0} = 1$$

$$A7_7 = \frac{5-2}{5-2} = \frac{3}{3} = 0$$

h. **Normalization candidate-08 (A 8)**

$$A8_1 = \frac{4-3}{4-3} = \frac{1}{1} = 1$$

$$A8_2 = \frac{5-4}{5-4} = \frac{1}{1} = 1$$

$$A8_3 = \frac{5-2}{2-2} = \frac{3}{0} = 0$$

$$A8_4 = \frac{5-2}{5-2} = \frac{3}{3} = 0$$

$$A8_5 = \frac{5-2}{2-2} = \frac{3}{0} = 1$$

$$A8_6 = \frac{5-3}{5-2} = \frac{3}{3} = 0$$

$$A8_7 = \frac{5-2}{5-2} = \frac{3}{3} = 1$$

The next stage will be carried out the multiplication of the normalization matrix by the preferential weight using the formula:



$$V_{(x)} = \sum_{i=1}^n W_j \cdot X_{ij} \dots \dots \dots (1)$$

The following is the calculation of the normalization matrix multiplication using equation (1):

$$\begin{aligned} A1 &= (0.25 * 1) + (0.20 * 1) + (0.15 * 1) + (0.10 * 1) + (0.10 * 1) + (0.10 * 1) + (0.10 * 1) \\ &= 1.0 \\ A2 &= (0.25 * 1) + (0.20 * 1) + (0.15 * 1) + (0.10 * 1) + (0.10 * 1) + (0.10 * 1) + (0.10 * 0) \\ &= 0.9 \\ A3 &= (0.25 * 0) + (0.20 * 1) + (0.15 * 0.33) + (0.10 * 0.67) + (0.10 * 0) + (0.10 * 1) + (0.10 * 0) \\ &= 0.4165 \\ A4 &= (0.25 * 0) + (0.20 * 0) + (0.15 * 1) + (0.10 * 1) + (0.10 * 0) + (0.10 * 1) + (0.10 * 1) \\ &= 0.45 \\ A5 &= (0.25 * 1) + (0.20 * 0) + (0.15 * 0) + (0.10 * 1) + (0.10 * 0) + (0.10 * 1) + (0.10 * 1) \\ &= 0.55 \\ A6 &= (0.25 * 1) + (0.20 * 1) + (0.15 * 0) + (0.10 * 0) + (0.10 * 1) + (0.10 * 0) + (0.10 * 1) \\ &= 0.65 \\ A7 &= (0.25 * 0) + (0.20 * 1) + (0.15 * 0.33) + (0.10 * 0.67) + (0.10 * 0) + (0.10 * 1) + (0.10 * 0) \\ &= 0.4165 \\ A8 &= (0.25 * 1) + (0.20 * 1) + (0.15 * 0) + (0.10 * 0) + (0.10 * 1) + (0.10 * 0) + (0.10 * 1) \\ &= 0.65 \end{aligned}$$

From the results of the equation, the multiplication of the normalization matrix shown in the following table will be produced:

Table 3. Final Results

No.	Name	Score
1	Nominee-01	1,0
2	Nominee-02	0,9
3	Nominee-03	0.4165
4	Nominee-04	0.45
5	Nominee-05	0.55
6	Nominee-06	0.65
7	Nominee-07	0.4165
8	Nominee-08	0.65

IV. CONCLUSION

The results of this study are in the form of lecturer who was elected as the head of the digital business study program . The results of the recommendations are in the form of the highest value of each candidate submitted. Where the results obtained are, lecturers with the code Candidate-01 get a value of 1.0, then Candidate-02 get a value of 0.9, Candidate-03 gets a value of 0.4165, Candidate-04 gets a score of 0.4165, Candidate-05 gets a value of 0.55, Candidate-06 gets a score of 0.65 Candidate-07 gets a value of 0.4165, Candidate-08 gets a score of 0.65 Based on these values, the decision was obtained that the chosen head of the digital business study program was a Candidate-01 lecturer with a value of 1.0. With the help of a decision support system for selected candidates, it is produced from the process of processing data on the value of the criteria of each candidate so that the results obtained are quite objective and most effective and competent as a head of study program.

REFERENCES

- Aldo, D. (2019). Pemilihan Bibit Lele Unggul Dengan Menggunakan Metode Weighted Product. *Jurnal Teknologi Dan Open Source*, 2(1), 15–23. <https://doi.org/10.36378/jtos.v2i1.138>
- Dona, D., Maradona, H., & Masdewi, M. (2021). Sistem Pakar Diagnosa Penyakit Jantung Dengan Metode Case Based Reasoning (Cbr). *ZONAsi: Jurnal Sistem Informasi*, 3(1), 1–12. <https://doi.org/10.31849/zn.v3i1.6442>
- WENDRA, Y., ALWENDI, ARDI, & ALDO, D. (2020). Metode Case Based Reasoning Untuk Identifikasi Penyakit Tanaman Padi. *Jursima*, 8(2), 103–110.
- Kaleb, B. J. (2019). Penerapan Sistem Informasi Manajemen Dan Pengawasannya Di Kantor Pelayanan Pajak Pratama Manado. *Jurnal EMBA: Jurnal Riset Ekonomi, Manajemen, Bisnis Dan Akuntansi*, 7(1), 781–790. <https://doi.org/10.35794/emba.v7i1.22555>
- Suriyani, I., Fitri, E. Y., & Andwar, E. (2020). Sistem Pendukung Keputusan Seleksi Penerimaan Beasiswa Dengan Metode Simple Adding Weighing (SAW). *Jurnal Sains Dan Informatika*, 6(1), 39–47. <https://doi.org/10.22216/jsi.v4i1>
- Aldo, D. (2019). Identifikasi Sanitasi Rumah Sehat dengan Metode Multifactor Evaluation Process. *Jurnal Sains Dan Teknologi Industri*, 16(2), 121. <https://doi.org/10.24014/sitekin.v16i2.5807>
- Habibie, D. R., & Aldo, D. (2019). Sistem Pakar Untuk Identifikasi Jenis Jerawat Dengan Metode Certainty Factor. *JOINTECS (Journal of Information Technology and Computer Science)*, 4(3), 79. <https://doi.org/10.31328/jointecs.v4i3.1055>
- Utami, A., Aldo, D., & Norhan, L. (2022). Analisa Ketepatan Jumlah Produksi Crude Palm Oil (CPO) dengan Fuzzy Inference System. 6(April), 1000–1009. <https://doi.org/10.30865/mib.v6i2.3933>
- Lubis, Z. (2018). Metode Baru Robot Pengantar Menu Makanan Menggunakan Android dengan Kendali PID Berbasis Mikrokontroler. In *Journal of Electrical Technology* (Vol. 3, Issue 2).



10. Ardi, A., Aldo, D., & Ahmadi, A. (2019). Sistem Pendukung Keputusan Menentukan Peserta Jamkesmas Dengan Metode Simple Additive Weighting. *Jurnal RESTI (Rekayasa Sistem Dan Teknologi Informasi)*, 3(2), 94–99. <https://doi.org/10.29207/resti.v3i2.802>
11. Stephano, A., Martha, S., & Rahmayuda, S. (2020). Sistem informasi peramalan tren pelanggan dengan menggunakan metode double exponential smoothing di Mess GM. *Jurnal Komputer Dan Aplikasi*, 8(1), 1–10.
12. Alwendi, D. A. (2020). Sistem Pendukung Keputusan Pemilihan Toko Handphone Terbaik Di Kota Padangsidempuan Menggunakan Metode Oreste. *JURSIMA Jurnal Sistem Informasi Dan Manajemen*, 8(1).
13. Marfuah, M., & Adam, S. (2021). Sistem Pendukung Keputusan menggunakan Simple Additive Weighting dalam Pemberian Reward Karyawan. *Walisongo Journal of Information Technology*, 3(2), 118–125. <https://doi.org/10.21580/wjit.2021.3.2.9681>
14. Sumarno, S., Gunawan, I., & Tambunan, H. S. (2019). Sistem Pendukung Keputusan Menentukan Aparatur Sipil Negara Terbaik Pada Dinas Pengelolaan Sumber Daya Air Unit Pelaksana Teknis Dinas dengan Metode Simple Additive Weighting. *Jurnal Sistem Komputer Dan Informatika (JSON)*, 1(1), 31. <https://doi.org/10.30865/json.v1i1.1377>
15. Sumarto, T. A., & Sihotang, F. P. (2021). Sistem Pendukung Keputusan Penilaian Kinerja Pegawai Magang Bakti. *Jurnal Teknologi Sistem Informasi*, 2(2), 187–199. <https://doi.org/10.35957/jtsi.v2i2.1377>
16. Ardianto, R., Herliana, A., Risqi, A., & Kusuma, S. (2022). Pemberian Kredit Telepon Seluler Menggunakan Metode Topsis Pada Mars Phone Cell Tasikmalaya. *10(1)*, 248–260.
17. Hariyanto, H., & Khotimah, S. (2018). Sistem Pendukung Keputusan Pemilihan Supplier Terbaik Telur Bermerk Menggunakan Metode SAW Studi Kasus : PT. GIANT PONDOK KOPI. *J I M P - Jurnal Informatika Merdeka Pasuruan*, 3(2), 47–53. <https://doi.org/10.37438/jimp.v3i2.171>
18. Nurmalasari, & Pratama, A. A. (2018). Sistem Pendukung Keputusan Pemilihan Supplier Menggunakan Metode AHP Pada PT Transcoal Pacific Jakarta. *Jurnal Teknik Komputer AMIK BSI (JTK)*, IV(2), 48–55. <https://doi.org/10.31294/jtk.v4i2.3509>
19. Zebua, D., & Hondro, R. K. (2021). Sistem Pendukung keputusan Pemilihan Pelatih Seni Dengan Menggunakan Metode Grey Absolute Decision Analysis (Gada) (Studi Kasus : Sekolah Perguruan Harapan Mandiri). 5, 29–34. <https://doi.org/10.30865/komik.v5i1.3645>
20. Sari, F. L., & Magister, M. (2018). Kepemimpinan Ketua Program Studi dalam Pengembangan SDM Berbasis Budaya Minangkabau. *13(2)*, 156–164.
21. Yuliatwati, I., & Idris, M. (2018). Sistem Pendukung Keputusan Pemilihan Ketua Program Studi Menggunakan Metode Weighted Product (Studi Kasus : STIT Mulatazam Lampung Barat). *Jtksi*, 01(01), 13–17.



An Android-Based Rabbit Gastrointestinal Disease Diagnosis Expert System With a Forward Chaining Method

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Abstract – Rabbits are animals prone to diseases, mainly affected by digestive system conditions. According to the author's experience, the interviews with rabbit breeders and veterinarians were located in Tangerang, if disorders in the digestive system do not receive proper treatment and will quickly result in death for the rabbit. Rabbit owners sometimes don't know what to do. Obstacles often encountered are limited time, costs, and the number of veterinarians who are still small so that they cannot handle the rabbit immediately. Based on the above problems, it is necessary to design an expert system application with an Android base. The purpose of creating a system is to diagnose diseases in the digestion of rabbits, accompanied by a solution. The method used is to use the forward chaining method to design a digestive disease diagnosis system. This study resulted in the design of an application based on android to diagnose diseases in the digestion of rabbits.

Keywords – *Android, App, Forward Chaining, Rabbit Disease, Expert System.*

I. INTRODUCTION

Pets are animals that we regularly keep in our homes and are sometimes thought of as everyday companions or even as having a very significant impact on their owners' lives. Because of their affinity for humans, rabbits are one of the most popular pets. Rabbits are not immune to the risk of disease, either, and untreated illness can be harmful [1]. Rabbits require special care to prevent illness, much as other domestic animals. This illness is to blame for the rabbit's demise, particularly if it has intestinal issues. based on the author's experience and conversations with vets and rabbit breeders. If indigestion is not adequately and promptly managed, it may result in the rabbit's death.

In Indonesia, rabbits are a simple animal to breed. There is excellent potential for meat production and procreation. Rabbits have a gestation period of about 30 days and can give birth 6–8 times a year. Up to 8 kits can be produced each time you give birth. The high death rate and declining output quality of mature rabbits, however, limit this potential. Some of the deaths happened when the rabbit was an adult, but the majority happened when it was still a baby bunny and hadn't been weaned. Sometimes the paired mother will not give birth either; however, upon investigation, it is discovered that the mate was unsuccessful or was unable to conceive. This issue is brought on by breeders' lack of awareness regarding diseases that affect rabbits and the likelihood of successful pregnancy after mating. Counselling on the traits of sick rabbits, the symptoms they feel, and how to handle them is one possible option. Farmers are instructed in the handling and injection of sick rabbits. The second method is to teach rabbits how to marry until they are successful at it and to look for pregnant rabbits 12 to 14 days after mating. Therefore, breeders are not required to wait 30 days before breeding again [2].

A sick rabbit's most typical presentation to the doctor is gastrointestinal stasis syndrome. The causes of this syndrome are frequently multifaceted, and an improper diet increases the risk of the condition in the rabbit. This disorder's complications can result in gastrointestinal obstruction, a potentially fatal illness that calls for urgent medicinal and occasionally surgical treatment. Rabbits may also have diarrheal symptoms [3].

In the other hand, the proximal colon is the primary location for the separation of the diet's digestible and indigestible components in the rabbit's complicated gastrointestinal physiology. The clinical significance of this system lies in the requirement of a regular diet rich in long particle length (> 0.5 mm) indigestible fiber to sustain the motility of the colon and cecum. The majority of common digestive issues in rabbits kept in captivity are caused by unsuitable meals (low fiber, excessive protein, high carbohydrate) and infrequently giving the rabbit treats to which it is not used. If captive rabbits are fed a diet that consists mostly of fibrous material, such as grass, hay, and fibrous weeds, many of these issues can be avoided [4].

In the book Goldmine of Ornamental Rabbits by [5] the authors discuss various illnesses that affect rabbits frequently, such as bloat, scabies, and diarrhea. The state of the cage's cleanliness and the quality of the food are two things that can cause rabbits to contract diseases more frequently, according to [6]. It's crucial to understand the numerous diseases that affect rabbits and how to feed them properly and healthily [7]. Additionally, it is uncommon for rabbit breeders and breeders who lack the time to consult a veterinarian directly. If a sick rabbit is not treated right away, the illness will get worse and may even kill the animal. Such things may be harmful to rabbit breeders and keepers [8].

There are instances when rabbit owners are unsure of what to do when their pet is ill. When owners have to take their animals to the doctor, they occasionally run into issues



like the distance to the nearest clinic, the lack of a veterinarian who treats rabbits, or a lack of free time. These inquiries can be used to formulate an issue that calls for an expert system to help the general public, particularly rabbit owners, learn about digestive disorders in rabbits as well as their symptoms and how to treat them.

The success of growers or hobbyists in caring for their rabbits can be determined by their health; rabbits kept as pets must continue to be healthy in order for the quality and production of rabbits to be sustained. Cleaning the cage, providing clean, boiling water, offering vitamin-rich diet, and other measures will help to improve rabbit health. Speaking of health, it relates to disease issues that can affect rabbits. Disease issues can lower quality and production in rabbit culture, thus rabbit cultivators and hobbyists must have knowledge of the symptoms, diseases, and how to handle disease in rabbits. It is required to develop an expert system as a means of managing diseases in rabbits because the knowledge of current rabbit specialists in the field does not allow for the provision of full information about rabbit diseases [5].

Both internal and external factors might have an impact on a breeder's success. When growing rabbits, maintenance management and marketing must be taken into account. Housing, nutrition, and pest and disease control systems are all included in maintenance management [9].

The Android operating system has benefits over other smartphone operating systems that make it simpler for developers to produce applications and their features to their specifications [10]. The user can become irritated by the simplicity and usability of Android-based applications without ever opening a webpage. Because the expert system can automatically be connected when the program is opened [11].

A computer program known as an expert system belongs to the field of computer science known as AI (Artificial Intelligence). Artificial intelligence is concerned with how knowledge is used to come to a conclusion that will be represented in a machine, and it aims to make things intelligent in terms of understanding through computer programs that are demonstrated by a concept and method of symbolic inference or reasoning made by computers. Knowledge-based or expert systems are artificial intelligence programs that produce knowledge of a particular subject and can solve problems within a certain domain at an expert level. A knowledge-based system that mimics the deductive reasoning of an authority figure in a given subject is known as an expert system [12]. The objective of this work is to develop a forward chaining expert system application that can identify digestive disorders in rabbits.

II. RESEARCH METHODOLOGY

The research method used in this study is the Forward Chaining method. Referring to the opinions of Russel and Norving in [13], the Forward Chaining Method is a search method or forward tracking technique that begins with existing information and incorporation rules to produce a conclusion or goal.

The forward chaining algorithm is logically described as a repetition application of the ponens mode (a set of inference rules and valid arguments); this method uses the inference engine by taking one of two reasons (thinking). Forward chaining begins to work with the available data and uses inference rules to get the other data until the target or conclusion is reached [14].

Inference machines that use forward chaining look for inference rules until they find one of the correct antecedents (theoretical postulates or IF - THEN clauses). When such rules are discovered, the decision-making machine can make inferences, or consequences (THEN clauses), which generate additional information from the data provided. The machine will repeat this process until the target is found [15]. The stages in this study start from data collection, system design, and implementation.

This article uses several data collection methods: literature study, documentation, observation, and interviews. It is a data collection technique by reading and comparing literature on the internet in articles, journals, and books [16]. Next comes the documentation. Data collection with documentation techniques is carried out by observing, researching, and mastering systems that have been seen or previously formed related to research objects to obtain valuable data. The interview itself is a data collection technique using question and answer sessions with experts to obtain the necessary information and data [17]. At this stage, the author observes and questions and answers through visiting a veterinary clinic and rabbit farm in order to get accurate results and later become the author's solution data in this expert system planning

The design of the algorithm in the expert system was created to make it easier to read the programs that have been created. Knowledge is divided into two main parts of its process: facts and conclusions. Then classify the facts into more specific facts and form rules with certain conclusions. Users provide input in the form of facts, namely user data and visible symptoms. Then enter the data into the rule, where the system will confirm whether the rule is correct. If it is not appropriate, the user will fill in other data. However, if appropriate, the rules or facts will be stored in a file in the database, and the file will go through a process by which the user can carry out the identification process [11].

In the identification process, conclusions will be drawn about diseases caused by symptoms entered by the user or diseases that cannot be found because the disease does not comply with the rules. The results obtained at the end of the plan are in the form of preventive and treatment solutions according to the type of disease.

The use of forward chaining in the expert system so that later users can choose facts in advance about gastrointestinal diseases suffered by rabbit owners. Next, a conclusion will be formed against the previously selected points. In the identification process, decisions will be drawn about infections caused by symptoms entered by the user or illnesses that cannot be found because the condition does not comply with the rules. The results obtained at the end of the plan are in the form of preventive and treatment solutions according to the type of disease.



The forward chaining method can provide much information from only a small data set. The advantage of this method is that it will work well when the problem starts from collecting/unifying information and then looking for what conclusions can be drawn from the report.

The following figure 1 is the design step of the algorithm in the author's expert system to make it effortless to read the program that has been made. If there is a failure in the knowledge base, the decision will be back in the appearing symptoms step. Here below the detailed algorithm arrangement,

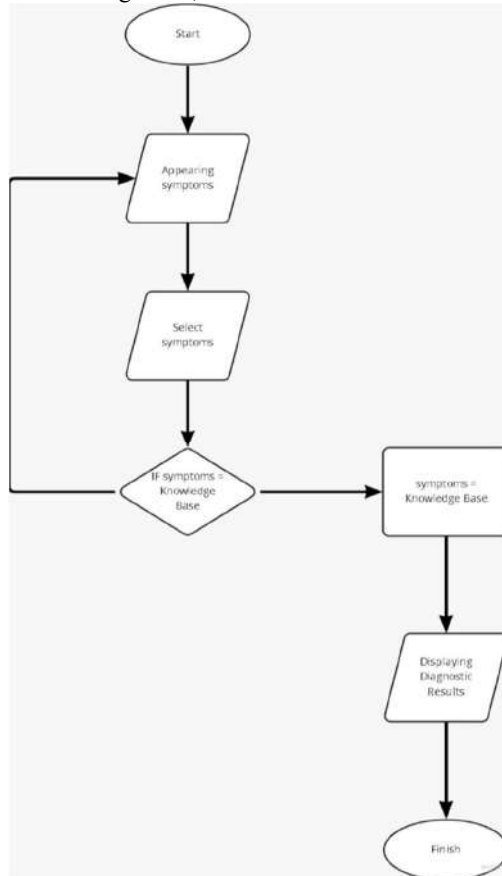


Figure 1. Algorithm Arrangement

III. RESULTS AND DISCUSSION

As for making a simple expert system with an android foundation for diagnosing disorders of the rabbit digestive system, the expert system designed incorporates symptom and disease data, which is a crucial object. The author has created the expert table below to make it easier to process knowledge base data input.

Table 1. Rabbit Digestive Disease Data

No	Disease Code	Name of Disease
1	P01	Bloating
2	P02	Coccidiosis
3	P03	Enteritis
4	P04	Hairball

Table 2. Rabbit Digestive Disease Symptoms Data

NO	Symptoms Code	Symptoms of Disease
1	G01	Sluggish
2	G02	Faint
3	G03	Bloated Stomach
4	G04	Diarrhoea
5	G05	Anorexia
6	G06	Abdominal Distension
7	G07	Watery Stool
8	G08	Slimy Stool
9	G09	Bloody Stool
10	G10	Depression
11	G11	Lose Weight

Table 3. Data Types of Rabbit Digestive Disease Solution

No	Solution Code	How to Overcome
1	S01	<p>Medicine: Bamboo Shoots K, Acepromazine, Permethyl</p> <p>Vitamin: B Complex, Probiotik, Sun-drop</p> <p>Lifestyle: Reduce food/drink consumption and give dry feed such as timothy grass</p> <p>If you feel the condition is severe, immediately consult a veterinarian</p>
2	S02	<p>Medicine: Sulfaquinoxaline, Nitrofurans</p> <p>Lifestyle: Separate rabbits from others, place rabbits in a clean and comfortable place, and provide nutritious food and drinks</p>
3	S03	<p>Medicine: Bamboo Shoots K, neomycin or chloramphenicol antibiotics</p> <p>Lifestyle: Reduce the consumption of food or drink and provide dry feed such as timothy grass</p>
4	S04	<p>Medicine: Hairball paw gel</p> <p>It is recommended to check with the veterinarian</p> <p>Lifestyle: Be diligent in combing the rabbit's fur so that the hair that falls out is not swallowed and do grooming regularly</p>

Table 1 shows that rabbit digestive diseases are inputted in the P01 to P04 code. Each code defined the name of the disease. In addition, as shown in table 2, the disease symptoms illustrate by G01-G11 codes. Finally, the disease solution presents in table 3 and using S01-S04 codes. It includes how to overcome the diseases, such as medicine will be taken and lifestyle changes.

Moreover, in making an adequate expert system the User Interface (UI) needs to be inputted some algorithm language using IF, AND, and THEN commands. Due to reflecting the knowledge, the rule method is used in the form of If-Then (IF-THEN). The rules consist of four types. Here below the detail of the rules:



Rule 1

IF Sluggish
AND Faint
AND Bloating Stomach
THEN Rabbit diagnosed with bloating

Rule 2

IF Diarrhoea
AND Lost Appetite
AND Abdominal distension
THEN Rabbit diagnosed with coccidiosis

Rule 3

IF Diarrhoea
AND Watery Stool
AND Slimy Stool
AND Bloody Stool
Then Rabbit diagnosed with Enteritis

Rule 4

IF Anorexia
AND Diarrhea
AND Depression
AND Lose Weight
Then Rabbit diagnosed with Hairball Disease

The entire four rules to be inputted based in basic data as shown in tables 1,2 and 3. The four diseases data inputted as THEN command. The previous IF and AND function is used to determine disease symptoms. Each rule has a different solution from the expert system. The expert system must analyse the input and output rules.

The expert decision tree that the author has made is based on the Expert Table as shown in figure 2,

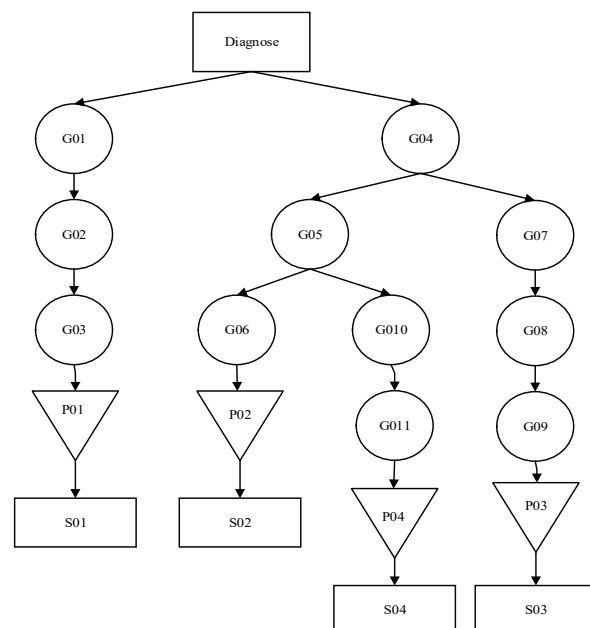


Figure 2. Root Decision Tree

The root decision tree based in figure 2 illustrates that the sequences are from G to P to S codes. It means that the rabbits have some symptoms and are diagnosed with a disease. After that, the expert system could give a decent solution to the rabbit.

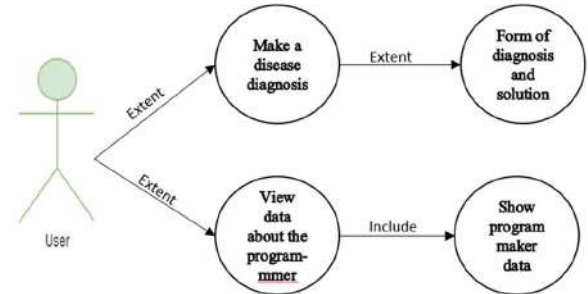


Figure 3. Use Case Diagram

Furthermore, as shown in figure 3 the case diagram explains the two steps which user can click within the expert system. The first way is to make a diagnosis of the disease and another step is function as a data viewer. The following table 4 is a description of the use case diagram of the user in the Rabbit Digestive Disease diagnosis system,

Table 4. Description of Use Case User Expert System for Diagnosis of Rabbit Digestive Disease

Use Case Name	Diagnostic Process
Requirement	
Goal	Users can access all the menus on the expert system for diagnosing rabbit digestive diseases
Pre-Conditions	Users know about the rabbit digestive disease diagnosis application
Post-Conditions	Users can find out the type of disease and the solution for handling it
Failed and Conditions	The user does not get the type of disease or solution to the problem in diagnosing rabbit digestive diseases
Primary Actors	User
Mainflow/Basic Path	1. Users answer questions in the form of digestive disease symptoms in rabbits 2. Users get information about the type of rabbit disease

In other hand, based in table 4 the expert system has an use case for user. There some steps from the case, requirement, goal, pre-conditions, post-conditions, failed and conditions, primary actors, also mainflow or basic path. All steps determine case for user utilisation. If there is any miss step or error, the expert system will be back to previous step.

The user interface is used to reflect the appearance of the application that will be used by the user.





Figure 4. Application User Interface Design (Welcome Section)

Subsequently, the dashboard menu of the expert system program as shown in figure 4 consists of diagnose and about section. If the user clicks on the diagnosis, you'll be sent to figure 5, which comprises questions that will provide the diagnostic findings and answers for a solution, as shown in figure 6. Whenever the user clicks the about, It advances to the section containing information on the expert system creator.



Figure 5. Application User Interface Design (Symptom Question Section)

In addition, based on the above picture as shown in figure 5, the expert system asked about the rabbit symptom

condition. The user must give a correct answer because it affects the next step.



Figure 6. Application User Interface Design (Diagnose and Solution Section)

Finally, the final view of the expert system as shown in figure 6 the diagnose and solution of the rabbit. The diagnose is inputted from previous rule data based in table 3. The data from the inputted rules is vital to give an appropriate answer.

IV. CONCLUSION

In summary, the forward chaining method can identify gastrointestinal diseases of rabbits according to the existing symptoms. The created system can only identify gastrointestinal disorders in rabbits. The Forward Chaining method in the diagnostic process will provide questions by the tree flow, so it must answer each question until the discharge is completed to get the final result (solution). The implication of the existence of an information system created is that users can quickly consult anywhere and anytime just by using a cellphone. Further research is expected to be able to develop applications by adding disease symptoms and solutions so that more diseases are detected and can be appropriately treated.

REFERENCES

- [1] A. Ayu, Z. Burhani, B. Harijanto, and H. Pradibta, "Sistem Pakar Diagnosis Penyakit pada Kelinci Menggunakan Metode Certainty Factor," *jip.polinema.ac.id*, p. 1, 2014, Accessed: Sep. 25, 2022. [Online]. Available: <http://jip.polinema.ac.id/ojs3/index.php/jip/article/view/82>
- [2] M. Akbar and E. Rokhana, "PENINGKATAN PENGETAHUAN PETERNAK TERHADAP PENYAKIT DAN KEBUNTINGAN KELINCI DI KELOMPOK TERNAK SUMBER REJEKI KOTA



- KEDIRI,” 2021. Accessed: Sep. 25, 2022. [Online]. Available: <http://journal.untar.ac.id/index.php/PSENAPENMAS/article/view/14982>
- [3] B. L. Oglesbee and J. R. Jenkins, “Gastrointestinal Diseases,” *Ferrets, Rabbits, and Rodents*, p. 193, 2012, doi: 10.1016/B978-1-4160-6621-7.00015-4.
- [4] R. R. Davies, *Gastroenterology, An Issue of Veterinary Clinics of North America: Exotic ...* - Tracey K. Ritzman - Google Books. 2014. Accessed: Sep. 25, 2022. [Online]. Available: https://books.google.co.id/books?hl=en&lr=&id=M8WLAwAAQBAJ&oi=fnd&pg=PP1&dq=Rabbit+Gastrointestinal+Physiology.+Veterinary+Clinics+of+North+America:+Exotic+Animal+Practice&ots=tIj9EfcCu&sig=cJe5UVV0FLId5tfla2StAvEhKts&redir_esc=y#v=onepage&q=Rabbit%20Gastrointestinal%20Physiology.%20Veterinary%20Clinics%20of%20North%20America%3A%20Exotic%20Animal%20Practice&f=false
- [5] D. A. Firman and D. D. S. Fatimah, “Pengembangan Sistem Pakar Diagnosis Penyakit Kelinci Berbasis Visual Prolog,” *Jurnal Algoritma*, vol. 13, no. 1, pp. 177–183, Aug. 2016, doi: 10.33364/ALGORITMA/V.13-1.177.
- [6] H. Hakim and Astuti. E.Z, “Sistem pakar untuk mendiagnosa penyakit kelinci berbasis web dengan menggunakan metode Forward Chaining,” *publikasi.dinus.ac.id*, vol. 15, no. 3, pp. 190–194, 2016, Accessed: Sep. 25, 2022. [Online]. Available: <http://publikasi.dinus.ac.id/index.php/technoc/article/view/1234>
- [7] D. Sianturi and G. Ginting, “Sistem Pakar Mendiagnosa Penyakit pada Kelinci dengan Menggunakan Metode Dempster Shafer,” *ejurnal.stmik-budidarma.ac.id*, vol. 7, no. 1, pp. 48–53, 2018, Accessed: Sep. 25, 2022. [Online]. Available: <https://www.ejurnal.stmik-budidarma.ac.id/index.php/pelita/article/view/883>
- [8] N. Komalasari, L. Affandi, and M. Hani’ah, “PENGEMBANGAN SISTEM PAKAR DIAGNOSIS PENYAKIT KELINCI DENGAN MENGGUNAKAN METODE CASE BASED REASONING,” 2020, Accessed: Sep. 25, 2022. [Online]. Available: <http://repota.jti.polinema.ac.id/113/>
- [9] J. Desmirati, S. Sutriyono, and B. Brata, “Manajemen Pemeliharaan dan Pola Pemasaran Kelinci di Kecamatan Kabawetan Kabupaten Kepahiang,” *ejournal.unib.ac.id*, Accessed: Sep. 25, 2022. [Online]. Available: https://ejournal.unib.ac.id/index.php/buletin_pt/article/view/11053
- [10] M. Pangkey, V. Poekoel, and O. Lantang, “Sistem Pakar Pendeteksi Kerusakan Handphone Berbasis Android,” *Jurnal Teknik Informatika*, vol. 8, no. 1, Jul. 2016, doi: 10.35793/JTI.8.1.2016.12825.
- [11] S. Nurajizah and M. Saputra, “SISTEM PAKAR BERBASIS ANDROID UNTUK DIAGNOSA PENYAKIT KULIT KUCING DENGAN METODE FORWARD CHAINING,” *Jurnal Pilar Nusa Mandiri*, vol. 14, no. 1, pp. 7–14, Mar. 2018, doi: 10.33480/PILAR.V14I1.81.
- [12] M. Arhami, *Konsep Dasar Sistem Pakar arhami - Google Scholar*. Yogyakarta, 2005.
- [13] A. Nurkholis, A. Riyantomo, and M. Tafrikan, “SISTEM PAKAR PENYAKIT LAMBUNG MENGGUNAKAN METODE FORWARD CHAINING,” *Majalah Ilmiah MOMENTUM*, vol. 13, no. 1, Jul. 2017, doi: 10.36499/JIM.V13I1.1757.
- [14] I. Akil, “ANALISA EFEKTIFITAS METODE FORWARD CHAINING DAN BACKWARD CHAINING PADA SISTEM PAKAR,” *Jurnal Pilar Nusa Mandiri*, vol. 13, no. 1, pp. 35–42, 2017, doi: 10.33480/PILAR.V13I1.12.
- [15] D. Kusbianto, R. Ardiansyah, and D. A. Hamadi, “IMPLEMENTASI SISTEM PAKAR FORWARD CHAINING UNTUK IDENTIFIKASI DAN TINDAKAN PERAWATAN JERAWAT WAJAH,” *Jurnal Informatika Polinema*, vol. 4, no. 1, pp. 71–71, Nov. 2017, doi: 10.33795/JIP.V4I1.147.
- [16] R. Y. Endra and D. Prasetya, “Analisis Perbandingan Teknik SEO Antara Google Webmaster Dan Bing Master Menggunakan Gap Analisis,” *Explore: Jurnal Sistem Informasi dan Telematika (Telekomunikasi, Multimedia dan Informatika)*, vol. 8, no. 1, Jun. 2017, doi: 10.36448/JSIT.V8I1.863.
- [17] F. F. Trisani, “STRATEGI HUMAS DINAS KOMUNIKASI DAN INFORMATIKA KABUPATEN BOYOLALI DALAM PENGELOLAAN INFORMASI PUBLIK,” *Ilmu Komunikasi*, vol. 2, no. 1, Dec. 2019, Accessed: Sep. 23, 2022. [Online]. Available: <https://journal.student.uny.ac.id/index.php/ilkom/article/view/15806>



Development of Website Public Complaint System Polibatam V2.0

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Abstract – The development of technology at this time, every agency certainly tries to improve the quality of its services. The Complaint Application is an information system that aims to provide aspirations for the performance of an agency. In this case the researchers took the case of the Batam State Polytechnic, where the campus wanted to realize Bureaucratic Reform at the Batam State Polytechnic by making a website-based Polibatam Complaint Application. Initially, the website was completed in the fourth semester during the implementation of Project Based Learning. In this case, the researcher conducted research to create a V.0 Complaints application with improvements from a website that had been built previously so that a website-based Public Complaint Application design was needed that was easy to use and could see responses to aspirations and complaints. The method that the researcher uses in designing the Polibatam V2.0 Complaint Application is the Waterfall model with MySQL as the Database Management System, as well as PHP, JavaScript as the programming language to be used and Laravel as the PHP Framework. The completed application is then tested using the black box testing methodology, which allows all functionalities to be executed and implemented in accordance with the previously created functional requirements.

Keywords – public complaint system, laravel, polibatam, website

I. INTRODUCTION

In the current era of globalization, information technology has become one of the main needs in everyday life. Providing information today is not as difficult as in the past, which only got information from television or newspapers [1]

. Then along with the development of technology that has become increasingly varied, currently information is expected to be faster and more efficient than before [2] and is also expected to be used as a facility that can channel people's aspirations and complaints [3]. Seeing the importance of information in the development of technology, that is what underlies the creation of the Website-Based Polibatam Complaints Website.

Initially the Polibatam Complaints Website was designed for Project Based Learning (PBL) activities in semester 4 which became the V1.0 Complaints Website. In the process, the Polibatam V1.0 Complaints Website has been completed, but when demonstrating the website to the management, there are additions to its features. Some of the added features are the Reporting account verification feature, the importance of this reporting account verification is to avoid false reports.

Furthermore, adding an email notification feature for officers when a report has been received, the importance of this email notification is to make it easier for officers to monitor reports, so that no reports are missed. Furthermore, the reporting feature is added to be able to respond to the officer's response. In addition to adding features, the Polibatam V2.0 Complaints Website also changes the system, the system change is that the response given by the unit will be sent first to management for verification.

If the response is valid then management will then send it to the reporter and if the response is not valid then the response will be returned to the relevant unit. The Polibatam V2.0 Complaint website also changes the unit system owned by Polibatam, where on the V1.0 website the unit part cannot be changed, so on the V2.0 Complaint website improvements are made so that the system owned by the website becomes dynamic.

II. RESEARCH METHODOLOGY

A. Data Collection Method

Method of data collection by conducting a question and answer session with internal supervisory unit (SPI) Polibatam as the project owner of the Polibatam Complaints Website. Interviews were conducted to obtain information about the system to be developed and how to handle complaints.

B. System Development Method

Development using the waterfall model is one type of application development model and is included in the classical life cycle, which emphasizes successive and systematic phases [4]. The waterfall model research methodology is described and depicted in Figure 1 as follows [5].

Needs Analysis, this phase serves to understand user needs for the system, information system boundaries about system requirements are obtained through interviews, surveys or discussions [6]. System Design, which is to describe the system based on the results of the needs analysis, this phase serves to provide an overview of what will be done and how it will look. Implementation, is the stage where the implementation of the system design that



has been built previously, starting from the approval system for responses to notifications via email.



Figure. 1 Waterfall Model.

Testing is the stage where testing the website that is being developed, to find out whether the website that has been developed is in accordance with the design and also ensures that there are no errors or bugs in the features that have been developed [7]. Maintenance is a process that is carried out after the system is used by users [8], [10], [11]

in this phase maintenance will be carried out on the website to update or repair. When the system has been completed, the system testing process will be carried out using the Black Box Testing method^[9]

C. System Overview

This Complaint System uses the website as a means of complaint. When the reporting user makes a report, the complainant needs to fill out the report form that has been provided. After filling out the report, the reporter can then send the report so that it is stored in the database. After the report is sent, the report will go to the admin officer for further verification of the report whether it is correct or not and if the report is correct then the admin can forward the report to the unit or management.

If the report is deemed necessary, the admin can forward the report to the unit and if the report is deemed necessary for investigation, the report can be forwarded to the management section. After the report gets to the unit, the unit can respond to the incoming report, when responding to the reporter, the response must first be verified by management, if management feels that something is lacking in the response that has been given, then management can return a response to the unit. The related response to be corrected immediately and if management feels that the response given is correct then management will forward the response that has been made by the unit to the reporter.

If the report goes to the management section, management can verify the incoming report, if it is true that the incoming report requires an investigation then management can carry out an investigation process, but if it turns out that the incoming report does not require an investigation then management can forward the report to the related unit to immediately respond to the report.

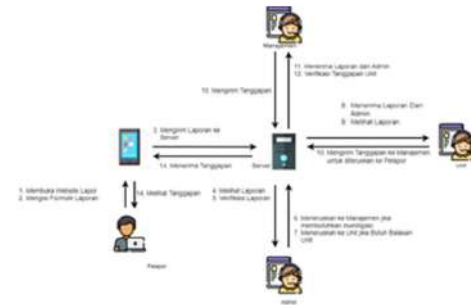


Figure. 2 System Overview.

D. System Comparison

Table 1. System Comparison

No	Complaint App Version 1	Complaint App Version 2
1	Register.	Register.
2	-	The system sends an email to the complainant to verify the account.
3	Login	Login
4	The reporter fills out the report	The reporter fills out the report
5	-	The system sends an email to the admin if a report comes in
6	Admin sees incoming reports	Admin sees incoming reports.
7	Admin can reject incoming reports.	Admin can reject incoming reports
8	The report is forwarded by the admin to the management to forward the report to the related unit.	The report will be verified by the admin, if the report does not require investigation then the report will be forwarded to the unit, and if the report needs investigation then the report will be forwarded to management.
9	-	The system sends an email to the unit when a report comes in.
10	-	The system sends an email to management when a report comes in.
11	Units can provide immediate response to the complainant.	The unit provides a response which will then be verified by management, if the response is valid then the response will be sent to the reporter, and if the response is not valid then the response will be returned to the unit for correction.
12	Management can send a direct response to the complainant.	Management can send a direct response to the complainant.
13	-	The system will email management when a response comes in.
14	-	The system will email the unit when a response is returned by management.
		The system will email the unit when a response is returned by management.
15	-	The reporter can provide a response to the response given by the officer.



The Polibatam Complaint Website version 2.0 is a development of the Polibatam Complaint Website version 1.0, in table 1 below, a comparison of the 1.0 and 2.0 systems is shown. Changes that occurred on the website version 2.0 were the addition of a new feature for sending account verification emails and messages to the reporter and admin, then also adding feature updates related to management such as viewing, responding and verifying responses from the unit before being sent back to the complainant. Shown in Table 1.

III. RESULTS AND DISCUSSION

A. Implementation and Result

The stages when using the Polibatam Complaints website are first by opening a browser and then accessing the website address of the Polibatam Report. The first page that will appear is the login page. Users can register as a reporter, officers can log in using an existing account. If the username and password entered on the login page are correct, the user has successfully entered the Polibatam Report system. The first step, we have the login page used by the reporter and officer, when the user successfully enters the username and password it will be forwarded to the dashboard page of each user. If the complainant does not have an account, the complainant can create an account on the account registration page.

After logging in, the complainant will enter the reporting dashboard page. The first page that will be found is the report form page as shown in Figure 3. When the reporter has made a report, the reporter can see a list of reports.



Figure 3. Report Detail

After submitting a complaint, the reporter can view the status of the complaint on the report list page. If the report is rejected by the officer, the reporter can display the reasons for the refusal given by the officer as shown in Figure 4. And if the report has been received and has been responded to by the officer, the reporter can see the officer's response.

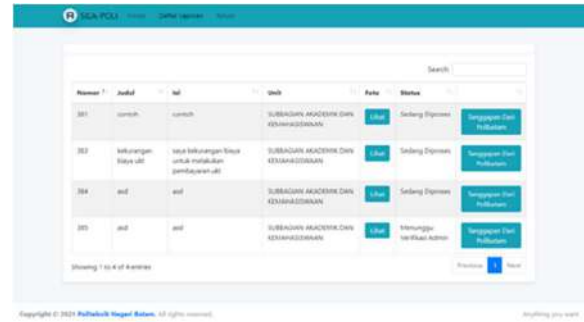


Figure 4. Report List

In Figure 5 the admin dashboard page is displayed, when the admin logs in, the initial page that will appear on the admin is the report information page. After seeing that there are reports that have been submitted, the admin will then open the list of incoming reports in Figure 4.

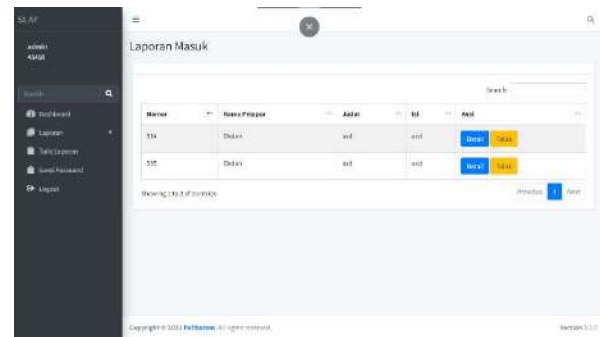


Figure 5. Officer's Response

After opening the list of incoming reports, the admin can then see the details of the reports that have been entered, and if the admin wants to forward the incoming reports, and if the admin wants to reject the report, the display of the reject report page is shown in Figure 6.



Figure 6. The Reason The Report Was Rejected

Next is the unit dashboard, when the unit logs into the system, the initial page that will appear is the report information that comes from the admin. When the unit sees that a report has been submitted, the unit will then open the incoming report list page, the incoming report list page. Once on the incoming report list page, the unit can view the details of the incoming report. After viewing the details of the incoming report, the unit can provide a response to the incoming report. After providing a response, the response will go to the management for further verification of the response that has been given by the unit. If the response is not appropriate, the response will be returned by



management to the unit and if it is appropriate, it will be forwarded to the reporter.

When management finishes logging into the system, management will enter the start page of the management dashboard, on the management dashboard page you can see information on reports that have been entered, reports that are being investigated, and responses that require verification, incoming report pages, and management as well. can see the report being investigated as shown in Figure 7.

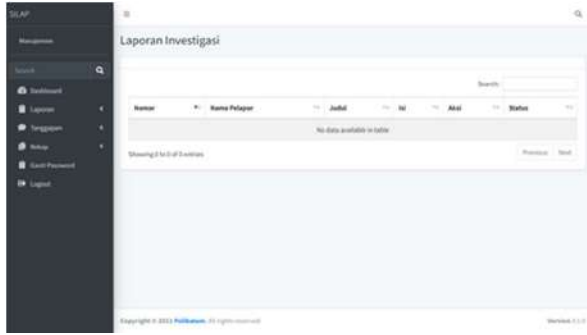


Figure 7. Investigation Report Page

B. Application Testing

Testing the Polibatam Complaint Application as a complaint website is carried out by testing based on its functional needs^{[13], [14], [15]}

. This test is carried out to see the functions that have been created. The testing method used is the Black Box Testing method so that the tests carried out will focus on the functionality of the system that has been built

No	Usecase	Testing Scenario	Testing Data	Result	Validation
1	Register	Enter name, email, phone number, username, password.	- Nama: Vicky Leonardo - Email : vickyleonardo23@gmail.com - No hp: 081234567789 - Username: Vicky - Password: xxx	The account was successfully registered and the system was successful	√
2	Login Reporter	Enter the registered and verified username and password.	- Username : Vicky - Password : xxx	Successfully logged in and redirected to the dashboard page.	√
3	Make Report	Include title, location, content, date of occurrence, unit of destination,	- Title : UKT - Location : Kampus - Subject : kekurangan biaya - Date : 15/06/2022 - Unit: Subbagian Akademik dan Kemahasiswaan - File : contoh.png	The report has been saved successfully and the notification email is sent to	√

		supporting files.		the admin officer.	
4	Reporter Gives Feedback	The complainant opens the complaint list, and opens the response page from polybatam and fills out the response form.	- Feedback : Tolong Konfirmasi lebih lanjut.	The response was successfully sent to the officer.	√
5	Login Admin	The officer enters the registered username and password	- Username: Admin - Password: xxx, - Username: sbak - Password: xxx, - Username: manajemen - Password: xxx.	Successfully logged in and redirected to the dashboard page.	√
6	Admin Reject Report	Admin opens the incoming report menu.	Give reasons for refusal on reports that have been previously made by the complainant.	The report status changed successfully and added the reason for the rejection of the report.	√
7	Admin forward report	Admin opens the incoming report menu.	Reports that have been previously can be forwarded to the unit if it requires a reply from the unit, forwarded to management if it requires investigation.	The report was successfully forwarded and a notification email was sent to the officer.	√
8	Unit Gives Feedback	Unit opens report list page, view report details, fill out feedback form	Enter feedback	Saved response, waiting for management verification, notification email to management successfully sent.	√
9	Report verification	Management	Reports that have been previously	Report saved,	√



	tion management	opens management dashboard page, opens report list, view report details	given will then be verified, if the unit requires a reply, the management will send a report to the unit, and if an investigation is needed, the report will be investigated.	email successfully sent to unit officer.	
10	Response verification management	Management opens the login feedback page, views the details of the response.	Responses from previously signed units will be verified.	The response was successfully sent to management.	√

IV. CONCLUSION

Based on all the development stages that have been carried out to create a Polibatam Complaints Website, it can be concluded that: The system has been built starting from an analysis in the form of an overview of the system, functional requirements, non-functional requirements and based on data collection that has been carried out. Based on the test results, it can be concluded that the Polibatam complaint website can run according to the needs that have been submitted by the Polibatam internal supervisory unit (SPI).

REFERENCES

[1] Jayanto, D. P. (2017). *Rancang Bangun Back-End "SIP": Sistem Informasi Aspirasi Dan Pengaduan Masyarakat berbasis Web Dengan Menggunakan Metode Microservice Springboot*. Institut Teknologi Sepuluh Nopember.

[2] Dwi Adje, M. (2015). *Sistem Informasi Konsep Dasar. The Effects of Brief Mindfulness Intervention on Acute Pain Experience: An Examination of Individual Difference*.

[3] Rohmatun, S., Widiastuti, I., & Khosyi'in, M. (2017). Pengembangan Sistem Informasi Pengaduan Masyarakat Kabupaten Jepara Berbasis Web. *Jurnal Transistor Elektro Dan Informatika (TRANSISTOR EI)*, 2(2), 111–123.

[4] Solihin, Nurjaya, & Ardhiansyah, M. (2022). *Membangun Web Dengan Framework Laravel 8*. Pascal Book.

[5] Dimas, R. (2019). *Apa itu SDLC Waterfall?* Medium.Com. <https://medium.com/dot-intern/sdlc-metode-waterfall-5ae2071f161d>

[6] Achmad Solichin. S.Kom. (2016). *Pemrograman Web dengan PHP dan MySQL - Achmad Solichin - Google Buku. Universitas Budi Luhur*.

[7] Rian, T. (2021). *Fungsi MySQL, Kelebihan Serta Kekurangannya*. Dqlab.Id. <https://www.dqlab.id/fungsi-mysql-kelebihan-serta->

kekurangannya

[8] Dharmawan, W. S., Purwaningtias, D., & Risdiansyah, D. (2018). Penerapan Metode SDLC Waterfall Dalam Perancangan Sistem Informasi Administrasi Keuangan Berbasis Desktop. *Jurnal Khatulistiwa Informatika*. <https://doi.org/10.31294/khatulistiwa.v6i2.160>

[9] Tri Snadhika Jaya. (2018). Pengujian Aplikasi dengan Metode Blackbox Testing Boundary Value Analysis. *Jurnal Informatika Pengembangan IT (JPIT)*, 3(2), 45–46. <http://www.ejournal.poltektegal.ac.id/index.php/informatika/article/view/647/640>

[10] Setiawan, R. (2021). *Metode SDLC Dalam Pengembangan*. Dicoding.Com. <https://www.dicoding.com/blog/metode-sdlc/>

[11] Humaira, A. (2021). *Model Waterfall: Pendekatan Sequential Life Cycle Model Paling Awal*. Glints.Com. https://glints.com/id/lowongan/model-waterfall-adalah/#.Y5_R2nZBzIU

[12] Ridwan, Mohammad, et all. (2019). Penerapan Helpdesk Ticketing System Dalam Penanganan Keluhan Penggunaan Sistem Informasi Berbasis Web. (*JUTIS*) *Jurnal Teknik Informatika*, 7(1), 71–82.

[13] Adam, S. I., Moedjahedy, J. H., & Lengkong, O. (2020). Pengembangan IT Helpdesk Ticketing Sistem Berbasis Web di Universitas Klatat. *Cogito Smart Journal*. <https://doi.org/10.31154/cogito.v6i2.273.217-228>

[14] Taftazan, R., Sudjadi, S., & Rochim, A. F. (2015). Perancangan Trouble Ticket System Pada Upt Puskom Universitas Diponegoro. *Transient: Jurnal Ilmiah Teknik Elektro*.

[15] Mathew, M. (2021). *What is Waterfall Model in SDLC? Advantages and Disadvantages*. Guru99.Com. <https://www.guru99.com/what-is-sdlc-or-waterfall-model.html>



The Influence of Social Media and Marketplace on Interest in Buying Bima Woven Fabric Products

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Abstract- The globe has become borderless as a result of the rapid development of information and communication technologies. People even use the internet as a means of buying and selling products and services online, which was subsequently referred to as the online market. The internet has evolved to adapt to the demands of the community and people even use the internet as a method of doing so. The Bima weaving company group use web marketing to supplement their sales efforts. The objective of this research is to investigate the role that social media and online marketplaces have in shaping consumer interest in purchasing bima weaving items. The data were acquired via the use of an online questionnaire, and there were a total of one hundred people that responded to the survey. sampling carried out utilizing the method of purposive sampling Excel 2013 and SPSS 22 for Windows are the programs that are used to handle the data. Quantitative research methodologies and multiple linear regression analysis are used in this work. This demonstrates that there is a beneficial influence that social media has on purchase interest. It is possible to draw the conclusion that there is a tight association between the independent and dependent variables as a result of the fact that the correlation value between the social media and marketplace variables from the purchasing interest variable is 75%. According to the findings of the t-test, the desire to purchase bima weaving items is significantly impacted by the use of social media. The marketplace is a crucial factor in determining the degree of purchaser interest in bima weaving items. According to the findings of the F test, the combination of the market and social media has a substantial impact on the amount of interest buyers have in purchasing Bima woven items.

Keyword : social media, marketplace, buying interest, bima weaving.

I. INTRODUCTION

The pace of technological progress is really high right now. At first, all we had to go on was radio, television, and newspapers; but, as time went on, people's information and communication demands became more sophisticated, prompting scientists to develop more cutting-edge technology. Internet users now use this newly coined term "online market" to purchase and sell products and services to one another. This is just one example of how the Internet has evolved to meet human needs as information and communication technologies have progressed. Bate'e (2019) was the first to study how consumers' use of social media affected their purchases from the Nias Gunungsitoli T-shirt Store. filled completed the survey using statistical methodology and data gathering procedures. Testing for dependability utilizing the approach of halves[1]. The goal of this study is to examine the impact of social media and online shopping on consumer behavior. the use of numerical analysis and descriptive checking.

Shopping online is a relatively recent phenomena in Indonesia. People would rather purchase online than make the effort to physically go to a store. Because of the rising popularity of purchasing online, several new virtual marketplaces have emerged. The most popular Indonesian online marketplaces are Shopee, Tokopedia, and Bukalapak. Youtube, Whatsapp, Facebook, and Instagram have the highest numbers of users in Indonesia. Tenun bima settled on Shopee, Instagram, and Whatsapp as their

primary marketing channels after analyzing user data from the most popular platforms[2],[3].

With 197 followers, Instagram is the platform where bima weaving items have attracted the most attention from consumers. Instagram has grown very popular among its users, both sexes. You may better connect with your customers for bima weaving items by using the Instagram business feature to see data on your followers, such as daily visitor statistics and the most popular posts. Bima, the weaver, has 570 WhatsApp friends. Whatsapp may bring businesses and their consumers closer together, which is great news for the sales of Bima woven goods. The marketing of bima weaving items in the market allows for hands-free management of all aspects of a sale, including product discovery, purchase, and assessment through rating and review tools. The company's operations are streamlined as a result. The results of internet advertising have been promising so far. Sales of Bima weaving goods have declined precipitously over the last year. The author is interested in the impact of marketing and social media on consumer interest in Bima Weaving goods because of the dismal 2021 sales figures.

II. RESEARCH METHODOLOGY

This investigation makes use of descriptive quantitative techniques and multiple linear regression analysis. This research uses a sample size of 100 participants drawn from the community of social media users and shoppers at the Bima Tenun marketplace. A method of sampling chosen for its usefulness or



interestingness (purposive sampling). Primary data collected through online survey questions. The measurement scale used is a Likert scale with a rating of 1. Strongly disagree, 2. Disagree, 3. Neutral, 4. Agree, 5. Strongly agree.

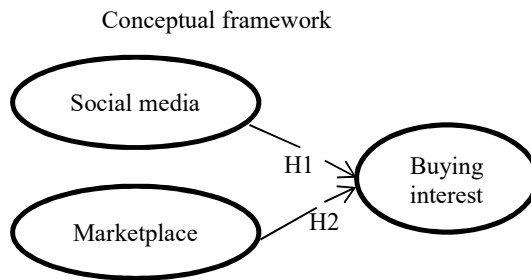


Figure 1. Conceptual framework

H1: Social media has a significant effect on buying interest in Bima Weaving products.
H2: Marketplace has a significant effect on buying interest in Bima Weaving products.
Hubungan Antar Variabel

The Influence of Social Media Characteristics on Consumers' Intent to Make a Purchase[4] found that there was a 70.9% correlation between Instagram engagement and

consumer propensity to make a purchase. The coefficient of correlation is statistically significant. This indicates that there is just one direction of influence between the two factors. Instagram's success as a social media platform correlates to increased customer enthusiasm for making a purchase. An individual's propensity to purchase is 70.9% more likely if they follow a brand on Instagram. Thus, it can be concluded that Instagram has a substantial impact on the Floating Market's customers' desire to make purchases.

H1: Social media has a significant effect on buying interest in Bima Tenun products.

Faisaletal's purchasing motivation and its link to a market variable. Chi-square test findings for e-commerce variables are shown in Survey (2020). The chi-square value was 16,309 and the p-value was 0.001 0.05 according to the SPSS chi-square test findings[5]. This indicates the influence of e-commerce factors on consumer demand for bima woven goods[6].

H2: Marketplace has a significant effect on buying interest in bima Tenun products

Table 1 Variables and Operational Definitions

Variables and Operational Definitions			
Variables	Variable Operational Definition	Indicator	Source
Social media (X1)	According to the most up-to-date version of the Cambridge Dictionary (2017), social media may be defined as an online platform that encourages participation in social networks via the production and dissemination of user-generated content.	1. Build a relationship 2. Brand building 3. Advertising 4. Promotion	Mileva theses dissertation [7]
Marketplace (X2)	According to Artaya and Purworusmiardi [8] in Nathasya (2018), a marketplace is a website that facilitates trade between businesses. The notion of the market place is quite similar to that of the conventional market. As a central meeting point for consumers and sellers, marketplaces facilitate the smooth transaction of goods and money.	1. System quality 2. Quality of information 3. Quality of service	DeLone & McLean (2003, in Faisal et al., 2020)
Purchase interest (Y)	Purchasing interest is defined by Tjiptono (2007, in Aptaguna and Pitaloka, 2016) as the degree to which a responder is likely to take action before a purchase decision is made.	1. Transactional interest 2. Referential interest 3. Preferential interest 4. exploratory interest	Tjiptono(2007, in Aptaguna & Pitaloka, 2016)

Data analysis technique

This research employs multiple linear regression analysis due to the presence of several independent variables. Also, just one dependent variable will be evaluated against the independent ones. Tests for normality, multicollinearity, heteroscedasticity, F-tests, t-tests, and coefficients of determination will be run to determine whether



or not the data is valid and trustworthy before any multiple linear regression analyses are performed.

III. RESULTS AND DISCUSSION

This study's findings are quantitative, based on responses from one hundred people. The sample of those who filled out the surveys came from people who follow the researchers online and shoppers at the Bima Tenun market. A Google form was used to conduct an online survey and gather the necessary information. A Likert scale was used as the assessment tool for this investigation.

Validation Test

Validation procedures assist in determining whether a set of questionnaires is enough for identifying variables, as stated by previous research [9]. The total number of altered elements in each question is correlated with one another, and this is how the validity score is calculated. Here are the guidelines for checking measurements:

- A. If the adjusted total item correlation > 0.300 , then the question is valid.
- B. If the total items < 0.300 , the question is invalid.

All questionnaire questions were certified valid or usable as measures of the variables of interest since their respective correlation values were larger than 0.300, as determined by the validation test. The cronbach alpha for (X1), (X2), and (Y) is larger than 0.60, as determined by the reliability test. The index generated by the survey instrument may be considered trustworthy if its Cronbach alpha is more than 0.60. Consequently, it follows that all of the study's independent and dependent variables may be relied upon.

Normality test

The P-Plot of Regression Standardized shows that the residual value follows a normal distribution. An ordinary residual value is one in which the point is on the diagonal.

Multicollinearity Test

Using a multicollinearity test, we see that the VIF value for the two independent variables is less than 10, and the tolerance for the two independent variables is more than 0.1. This indicates that the two predictors are not multicollinear.

Linearity Test

The linearity test shows that the independent variable (social media) is not linear with the dependent variable (buying interest) because the significance value is less than 0.05.

The significance value of the marketplace variable is 0.561 which means it is greater than 0.05, but the independent variable (marketplace) is linear with the dependent variable (buying interest).

Heteroscedasticity Test

A test for heteroscedasticity reveals that the data points do not cluster. As a result, we may say that this regression does not have a non-uniform variance.

T - Test

a. The Impact of Social Media on Consumer Intent to Purchase For those interested, the t-test yielded a tcount of 5.283 and a Sig value of 0.020. This demonstrates that both the tcount and Sig values are larger than 0.05, since the tcount is greater than 1.98472 and the Sig value is greater than 0.05. Accordingly, factors related to social media significantly affect consumer enthusiasm for Weaving Bima wares.

b. A t-value of 3.618 and a sig-value of 0.000 were calculated for the market for buyer interest. The tcount number is more than the ttable value of 1.987472, and the sig value is greater than 0.05, proving that the null hypothesis cannot be rejected. Demand for Bima woven goods is therefore significantly influenced by market conditions.

F - Test

The value of Ftable was 3.09 (Table F at the 5% significant level) when the equations $F_{table} = (k:n-k)$, $F_{table} = (2:100-2)$, and $F_{table} = (2:98)$ were applied to the data from the research, which included two independent variables and 100 samples. The numbers in the table add up to an Fcount of 62,612 and a Sig of 0.000. Since Fcount is larger than Ftable 3.09 and Sig is less than 0.05, we may conclude that the significance level is low. Together, social media and Marketplace have a considerable impact on consumer enthusiasm for Bima Weaving goods.

Coefficient of Determination

Based on the results of the coefficient of determination test, we may infer that the two independent variables (X1 and X2) are moderately and positively correlated ($R = 0.751$) with respect to the dependent variable (buyer interest = Y). It may be inferred that there is a tight association between the independent variable and the dependent variable in this research since the correlation value (R) is near to 1. Then there's the correlation, According to the data in the table above, X1 and X2 account for 55.5% and 44.5% of the variance, respectively, while the remaining 7.5% is explained by factors not included in the current study.

The purpose of multiple linear regression analysis is to determine the presence or absence of



the influence of the independent variable with the dependent variable. Based on the tests performed, the following equation is obtained:

$$Y = 3,310 + 0,394 X1 + 0,158 X2 + e$$

With this equation, it will show the relationship between the X variable (Social Media and Marketplace) with the Y variable (Purchase interest). The interpretation is as follows:

1. The value of the constant is 3.310. This means that if the independent variable does not change, namely on social media and the marketplace ($X1$ and $X2 = 0$), then the willingness to buy is positive at 3.310.
2. The regression coefficient value for the social media variable is positive at 0.394. In other words, assuming the social media variable ($X1$), the marketplace variable ($X2$) increases by 1 unit, and if the constant is 0, the level of buying interest increases by 0.394. Social media variables show a positive contribution to buying interest, so the better the marketing through social media, the more likely consumers are to buy.
3. The value of the marketplace variable regression coefficient is positive at 0.158. That is, assuming the marketplace variable ($X2$) increases by 1 unit on the social media variable ($X1$) and the constant is 0, it will increase the level of buying interest by 0.158. The marketplace variable makes a positive contribution to buying interest, the better social media works, the more likely consumers are to be interested in buying.

The Effect of Social Media ($X1$) on Buying Interest (Y)

Based on the results of the t test done with the SPSS program, the results of the test show that social media variables have a big impact on buying interest. This shows that how much marketing there is on social media has an effect on how much people want to buy. So, it can be said that what people do on social media affects their desire to buy.

Effect of Marketplace ($X2$) on Purchase Intention (Y)

Based on the results of the t-test done with the SPSS program, the market variable has a big effect on buying interest. This shows that the quality of the system, the quality of the information, and the quality of the service in the market all affect consumer interest in buying. So, it can be said that what people do on social media affects their desire to buy.

Research Implication

People spend more time in front of the computer in this age of technology. This has caused people to switch from shopping in stores to shopping online. So, this research is likely to be useful for businesspeople and marketers, especially the weaving group of Bima Regency,

which wants to use online marketing to implement its business strategy[10]. The results of this study show that both social media and the marketplace make people more interested in buying. Business owners should focus on online marketing to get more people interested in buying their products[11]. Also, business owners must be able to give customers things to do, like shopping without having to go to the store. This can be used with real product photos or real pictures. The color of the product should be similar to the color of the product being photographed, and the product's specs should be clear.

IV. CONCLUSIONS

Conclusions

Based on what has been learned about how social media and the market affect the desire to buy bima weaving products, Among the conclusions reached are:

1. Social media makes people more interested in buying products from Bima Weaving.
2. Marketplace makes people more interested in buying products from Bima Weaving.

By using a sample of 100 respondents with a population of 197 Instagram followers and 200 followers of a marketplace store.

Recommendations

Suggestions for People in Business
When using social media to market a business, especially an online business, it's best to pay attention to the content being promoted. So that people will be interested in the products being sold, the content must be interesting and the information must be clear. It is also important to build good relationships with followers and build brands. If you want to market on a marketplace, you should choose one where both sellers and buyers are protected. Information that is easy for potential buyers to understand, up-to-date, and relevant to what they need. Have good service quality, like being quick to help and giving a guarantee.

This study only looks at Instagram, WhatsApp, and the online marketplaces Shopee and Tokopedia. For more research, it is likely that social media objects and marketplaces other than those that have already been studied will be added. In future research, they plan to add other independent variables, such as websites, emails, and so on, to find out how other online marketing affects variables like buying interest.

The research in this study has a weakness in that it is hard to find people to talk to in the Bima Weaving market. Researchers gave out questionnaires to Bima Tenun buyers on Shopee and Tokopedia, but only a few of them filled them out.

REFERENCES



- [1] Ramdhan, J. M. (2019). Pengaruh Media Sosial dan E-Commerce Terhadap Keputusan Pembelian Distro House Of Smith. *Almana : Jurnal Manajemen Dan Bisnis*, 3(3), 534–544. <http://journalfeb.unla.ac.id/index.php/almana/article/view/1267>
- [2] Untari, D., & Fajariana, D. E. (2018). Strategi Pemasaran Melalui Media Sosial Instagram (Studi Deskriptif Pada Akun @Subur_Batik). *Widya Cipta*, 2(2), 271–278. <http://ejournal.bsi.ac.id/ejurnal/index.php/widyacipta>
- [3] Aziz, M. A. T. (2022). *ANALISIS PENGARUH PROMOSI MELALUI PENGGUNAAN MEDIA SOSIAL INSTAGRAM TERHADAP MINAT BELI KONSUMEN DI AMSTIRDAM COFFEE AND ROASTERY*. Universitas Negeri Malang.
- [4] Tutiasri, R. P., Widiastuti, E. J., Murti, S. T. R., & Priscillia, I. (2021). The Use of Instagrams as A Digital Communication Media by Holyspicy in The Covid-19 Pandemic. *Metafora: Education, Social Sciences and Humanities Journal*. <https://doi.org/10.26740/metafora.v5n1.p25-37>
- [5] Janie, D. N. A. (2019). Statistik Deskriptif dan Regresi Linier Berganda dengan SPSS. *Statistik Deskriptif Dan Regresi Linier Berganda Dengan SPSS*.
- [6] Irawan, D., Rahsel, Y., Udin, T., Manajeamn, P., Islam, P., & Rejo, G. (2017). Perancangan Electronic Commerce Berbasis B2C. *Jurnal TAM (Technology Acceptance Model)*, 8(1), 58–62.
- [7] Lubiana, M. (2018). *Pengaruh Social Media Marketing terhadap Keputusan Pembelian (Survei pada Mahasiswa Sarjana Jurusan Ilmu Administrasi Bisnis Angkatan 2014/2015 Fakultas Ilmu Administrasi Universitas Brawijaya yang Membeli Starbucks Menggunakan LINE)*. Universitas Brawijaya.
- [8] Istyarini, W., Artaya, I. P., Purworusmiardi, T., Sukoco, A., Kamisutara, M., & Bon, A. T. (2020). Marketplace effectiveness in increasing sales concentration of small business products during the covid19 pandemic. *Proceedings of the International Conference on Industrial Engineering and Operations Management*.
- [9] Asri, S., & Susanti, F. (2018). *FAKTOR FAKTOR YANG MEMPENGARUHI MINAT BELI PADA E-COMMERCE LAZADA.CO.ID (Studi Pada Mahasiswa Jurusan SI Manajemen "STIE KBP" Padang)*.
- [10] Nisa, K., Laili, A., Qolbiyatul, S., & Suyanto, M. (2018). Strategi Pemasaran Online dan Offline. *Abdikarya: Jurnal Karya Pengabdian Dosen Dan Mahasiswa*, 01(1), 55–60. <http://jurnal.untagsby.ac.id/index.php/abdikarya/article/view/2018>
- [11] Suharsono, R. S., & Sari, R. P. (2019). Pengaruh Promosi Media Online terhadap Keputusan Pembelian Produk Hijab. *JAMIN: Jurnal Aplikasi Manajemen Dan Inovasi Bisnis*. <https://doi.org/10.47201/jamin.v1i2.28>



Mini Thesis Supervisor Recommender System Using Simple Additive Weighting Algorithms: A Case Study of Universitas Internasional Batam

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Abstract – Currently, the selection of thesis supervisors in Faculty of Computer Science at Universitas Internasional Batam is done based on direct consideration of the supervisor candidate's competence, functional, and education. However, this thesis supervisor selection process is not very effective if the student doesn't know a suitable supervisor for the topic of the thesis they have chosen. Therefore, a decision support system is required to determine the thesis supervisor so that the thesis submitted by student matches with the competence of the thesis supervisor candidate. The primary goal of this research is to create a decision support system application that can assist in determining the thesis supervisor. The Research and Development (R&D) technique was employed in this study, with the Simple Additive Weighting (SAW) decision making approach and the ADDIE model for the development process. Lecturer data was collected by distributing questionnaires. Based on the result of SAW calculations, it was found that alternative 7 (A7) and alternative 4 (A4) were the best alternative. From the result of testing on application, the application was able to provide recommendations for thesis supervisors to users based on the calculation using SAW Method. Future research may try to use or combine other decision-making methods, such as AHP or Apriori.

Keywords – Decision Support System, Lecturer, Thesis, SAW Method

I. INTRODUCTION

College students are individuals who are pursuing higher education at a college, which includes high schools, academies, and the most common is a university. In addition to being given an academic burden to complete lecture assignments, college students also play an important role in the development of a country [1]. In process of completing the undergraduate education level, college student must work on a final project or mini thesis. Final project or mini thesis is one of the requirements for undergraduate students to graduate with a bachelor's degree by presenting a scientific work which is the result of measuring academic ability from the field of science that they are engaged in, by describing analytically and systematically the result of research carried out in accordance with the direction of the supervisor.

In Indonesia, normally undergraduate programs can be completed in eight semesters or four years and the final project or mini thesis is completed in the last semester of the study period as regulated by each faculty, following university standards [2]. Selection of a supervisor is something that must be done by college students to be able to complete their study period. In the preparation of the mini thesis, the supervisor plays an important role in the process of making a student's thesis. In the selection of supervisors sometimes there are less than optimal decisions where the appointed lecturer doesn't match the student criteria, as a result the resulting thesis is poor of quality or students need takes longer time in the [3]. The selection of a supervisor will greatly affect the length of time a student's graduates. Therefore, the selection of supervisors is very important for college students.

Research of Palopak and Lumbantobing on 2019 developed a decision support system (DSS) by utilizing

the simple additive weighting (SAW) method as a process in selecting dorm residents. In this selection process several criteria are used to determine which prospective occupants will be accepted. In this study, the criteria used were parental income, number of dependents of parents, number of siblings, willingness to take 17 credits, self-cooking, student debt, and electricity tariffs. The result of this research is web-based application that applies SAW algorithm in the selection of university student dormitory residents [4].

The research of Janti on 2020 conducted an analysis for the selection of shipping expedition services using the Simple Additive Weighting (SAW) Method. The criteria used in this research are price, time weight, and volume. In this study, the result of JNE YES expedition was found as the best alternative based on the time and weight. Meanwhile, based on volume Wahana holds the best alternative [5].

The research of Permatasari and Adhi on 2020 discusses the development of a decision support system to determine the tendency of a student to take courses within the scope of informatics and computer engineering using the Apriori algorithm. The research method used in this study was Research and Development (R&D). The research stage is carried out to collect data in the form of patterns of relationships that occur between students and elective courses. While at the development stage, web-based application development is carried out using the PHP Programming language. The result of this research was a web-based decision support system that is used to generate association rules that can be used as consideration in opening elective courses [6].

Based on the literature review and the background above, to help overcome the above problems, a decision support system is needed. This study focuses in



developing a decision support system using simple additive weighting algorithm to help college student in the process of supervisor selection.

II. RESEARCH METHODOLOGY

A. Decision Support System

A Decision Support System (DSS) is typically designed to aid in the resolution of a problem or an opportunity. The decision support system (DSS) application is used for decision making. A Computer Based Information System (CBIS) is used in a decision support system application to support solutions to particular unstructured management problems [7]. A decision support system is a system that may make suggestions for decisions based on a range of criteria provided by the decision-making systems approach method, including AHP, SAW, ARAS, and others. In the business world, DSS are frequently used in decision-making processes [8].

B. Simple Additive Weighting (SAW)

The Simple Additive Weighting (SAW) approach is also known as the weighted summing method. Finding the weighted sum of performance ratings for each alternative across all criteria is the main goal of the SAW approach. The SAW technique requires that the choice matrix (X) to be normalized to a scale that is equivalent to all of the alternative ratings that are provided [9], [10]. SAW Method required normalization process before ranking process. While in the normalization process, there are two types of criteria which is benefit and cost [11].

In general, the stages for applying the AHP technique to a problem are as follows [12], [13]:

- Determine or chose the alternative, namely A_i
- Identifying the criteria that will be used in decision making, namely C_i .
- Preparing the decision matrix using criteria (C_i)
- Normalizing the matrix using the equation adjusted with the type of attribute (benefit or cost) to create the normalized matrix R.

$$R_{ij} = \begin{cases} \frac{x_{ij}}{\max x_{ij}} & \text{if } j \text{ atribut is benefit} \\ \frac{\min x_{ij}}{x_{ij}} & \text{if } j \text{ atribut is cost} \end{cases} \quad (1)$$

Information:

R_{ij} : Normalization result value.

x_{ij} : attribute value for each criterion.

$\max x_{ij}$: the highest value for each of the criteria.

$\min x_{ij}$: the lowest value for each of the criteria.

- The sum of the matrix multiplication normalized R with the weight vector to achieve the highest value picked as the best option (A_i) as a solution is the result of the ranking procedure.

$$V_i = \sum_{j=1}^n W_j R_{ij} \quad (2)$$

Information:

V_i : result of each alternative's ranking

W_j : weighted value for each criterion

R_{ij} : Normalization result

The largest value of V_i identifies as the best alternative (A_i)

C. Research and Development Stage

To aid in the development of this research, a defined structure for the steps is required. This framework represents the steps that will be done to solve the difficulties that will be described. This research is divided into 2 stages which is research stage and development stage. Figure 1 is the flow of research stage:

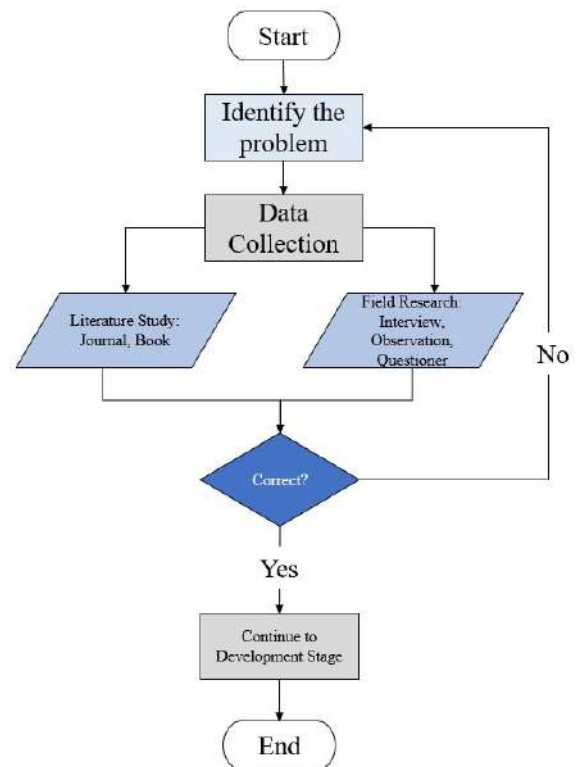


Figure 1 Research Stage

- Identification the problem that occurred at Universitas Internasional Batam, right now the student selected the thesis supervisor only by personal wishes without considering the supervisor main skill or others information.
- Data for this study were gathered through interviews, observations, questioners, and a review of the literature. It is done at this stage to collect all the information that will be used to support this research. Observations were conducted directly at Universitas Internasional Batam by looking at how college students choose their thesis supervisor. The interview was performed by directly asking college students how they chose their supervisor. Questionnaires are used to gather data on lecturers. The literature study includes reading a variety of sources of information connected to the research title.. Researchers used online journals and books as reference sources.



Meanwhile the application development stage will use ADDIE Framework. The ADDIE model is a popular instructional design framework among application designers and developers. It is used by instructional designers in the development and training processes [14]. ADDIE framework consists of 5 steps as shown in the figure 2.

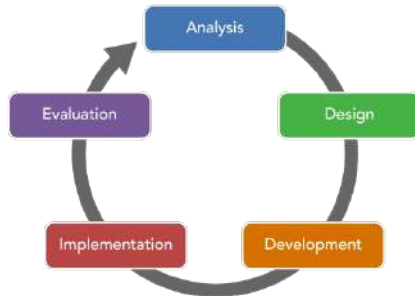


Figure 2 ADDIE Framework

- The analysis is the preliminary stage that serves as the foundation for further development [15].
- The ADDIE web-based decision support application's design phase can be described as an overview of creating a unique system design that functions as a single, cohesive unit. Stages to design a system in general can be done after completing the needs analysis stage [16].
- Development stage is the process of realizing the design steps in real form. At this stage, the SAW algorithm will be implemented in a web-based application.
- Implementation stage is the stage to do testing to the application developed in the development stage.
- Evaluation stage is the stage to determine the success of the application that has been made.

III. RESULTS AND DISCUSSION

A. Determining of the criteria

This research using Simple Additive Weighting (SAW) which important to determine the criteria and weight for every criterion in process of supervisor selection [17]. In determining thesis supervisor, criteria are needed which later each alternative will be compared based on these criteria. From the result of consultations with thesis supervisor, the following table 1 are the criteria used to determine the thesis supervisor.

Table 1 Criteria and Sub Criteria

Criteria	Sub Criteria
Education	S2
	S3
Functional	Instructor
	Expert Assistant
	Lecturer
	Head Lecturer
	Professor
Competence	Web Design (Level 1)

	Machine Learning (Level 2)
	Digital Marketing (Level 3)
	Design (Level 4)
	Strategic Information System (Level 5)
Lecture Status	Permanent
	Part Time
Number of mentoring students	0-5
	6-10
	11-15
	16-20
	21-25

B. Weight for every criterion and sub criteria

The weighting for criteria and sub criteria was determined subjectively. Below is the result of weighting:

Table 2 Weight Score

Category	Value
Very Low	0.1
Low	0.25
Medium	0.5
High	0.75
Very High	1

Table 3 Criteria and Weight

Criteria Code	Criteria	Type	Weight
C1	Education	Benefit	25%
C2	Position	Benefit	15%
C3	Competence	Benefit	35%
C4	Lecture Status	Benefit	15%
C5	Number of mentoring students	Cost	10%

Table 4 Sub Criteria Weight

Criteria	Sub Criteria	Weight
Education	S2	0.50
	S3	1.00
Functional	Instructor	0.10
	Expert Assistant	0.25
	Lecturer	0.50
	Head Lecturer	0.75
	Professor	1.00
Competence	Level 1	1.00
	Level 2	0.75
	Level 3	0.50
	Level 4	0.25
	Level 5	0.10
Lecture Status	Permanent	1.00
	Part Time	0.50
Number of mentoring students	0-5	0.10
	6-10	0.25
	11-15	0.50
	16-20	0.75
	>20	1.00

C. Supervisor Candidate Data



The data of supervisor candidate was collected from questioner. Table 5 is the sample data of the supervisor.

Table 5 Supervisor Candidate Data

Alternative (Ai)	Education	Functional	Competence	Status	Number of Mentoring Students
A1	S2	Lecturer	Digital Marketing	Permanent	>20
A2	S2	Lecturer	Cyber Security	Part Time	16-20
A3	S2	Lecturer	Design	Permanent	11-15
A4	S2	Lecturer	Machine Learning	Permanent	6-10
A5	S2	Lecturer	Machine Learning	Part Time	>20
A6	S3	Head Lecturer	Strategic Information System	Permanent	0-5
A7	S2	Lecturer	Machine Learning	Permanent	6-10

D. Simple Additive Weighting Implementation

Table 6 is the initial matrix of the data

Table 6 Supervisor Candidates Categorical Data

0.50	0.50	0.50	1.00	1.00
0.50	0.50	0.10	0.50	0.75
0.50	0.50	0.25	1.00	0.25
0.50	0.50	0.75	1.00	0.25
0.50	0.50	0.75	0.50	1.00
1.00	0.75	0.10	1.00	0.10
0.50	0.50	0.75	1.00	0.25

Based on table 6 we will do normalization for that data. The normalization will be calculated based on the type of the criteria. For the benefit criteria will use the largest value. There are three criteria that are classified as benefits which is C1 with largest value 1, C3 with largest value 1, and C4 with largest value 1. And for cost criteria will use the smallest value. There are two criteria that are classified as cost which is C2 with smallest value 0.5 and C5 with largest value 0.

After calculated the largest or smallest value for each criterion, that number will used to calculate the final number using Simple Additive Weighting (SAW) formula. Based on the result of the normalization of initial matrix, it produces an R Matrix. Table 7 is the result of normalized R Matrix.

Table 7 R Matrix

0.50	0.67	0.67	1.00	0.10
0.50	0.67	0.13	0.50	0.13
0.50	0.67	0.33	1.00	0.40
0.50	0.67	1.00	1.00	0.40
0.50	0.67	1.00	0.50	0.10
1.00	1.00	0.13	1.00	1.00
0.50	0.67	1.00	1.00	0.40

After calculated R Matrix, then the ranking is calculated using equation 2. The criteria weight (W) for the calculation will based on table 3, $W = [25; 15; 35; 5; 20]$.

$$V_{A1} = (25)(0.50) + (15)(0.67) + (35)(0.67) + (15)(1) + (10)(0.1) = 62$$

$$V_{A2} = (25)(0.50) + (15)(0.67) + (35)(0.13) + (15)(0.50) + (10)(0.1)$$

$$V_{A3} = (25)(0.50) + (15)(0.67) + (35)(0.33) + (15)(1) + (10)(0.1)$$

$$V_{A4} = (25)(0.50) + (15)(0.67) + (35)(1) + (15)(1) + (10)(0.4)$$

$$V_{A5} = (25)(0.50) + (15)(0.67) + (35)(1) + (15)(0.5) + (10)(0.1)$$

$$V_{A6} = (25)(1) + (15)(1) + (35)(0.13) + (15)(1) + (10)(1) = 69.55$$

$$V_{A7} = (25)(0.50) + (15)(0.67) + (35)(1) + (15)(1) + (10)(0.4)$$

Based on the results of the above calculations, it produces the best alternative thesis supervisor. Best alternative based on the calculation are alternative 4 and alternative 7 and alternative 4 with score 76.55. The following table 8 is the ranking results.

Table 8 Ranking Results

Alternative (Ai)	Result	Ranking
A7	76.55	1
A4	76.55	1
A6	69.55	3
A5	66.05	4
A1	62.00	5
A3	53.10	6
A2	35.90	7

E. System Implementation



Figure 3 Main Criteria Page

Main criteria page as shown in figure 3 used to view existing criteria. At this page user can also change the weight or the type of each criterion.

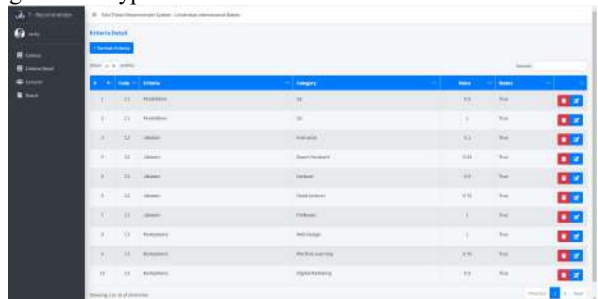


Figure 4 Sub Criteria Page

Sub criteria page as shown in figure 4 used to view existing sub criteria. At this page user can add new sub criteria, update and delete it.



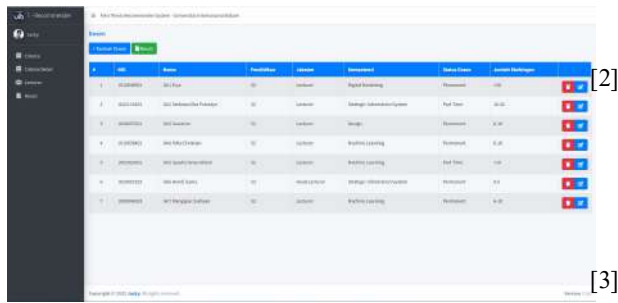


Figure 5 Lecturer Page

Lecturer page as shown in figure 5 used to view all existing lecturer information.



Figure 6 Add New Lecturer Page

In add new lecturer page as shown in figure 6, users can add new lecturer information. Users need to fill all required field in this page before saving the data.



Figure 7 Result Page

Result page as shown in figure 7 will be showing all the calculations result such as alternative matrix and final ranking data. Based on the test result on the web-based application system, each of the top alternatives that have the highest value can be used as the consideration in the selection of mini thesis supervisor.

IV. CONCLUSION

This study using Simple Additive Weighting algorithm to help in the selection of mini thesis supervisor. By developing decision support system application for mini thesis supervisor selection, it will facilitate and speed up appropriately choosing a mini thesis supervision. The ranking results using SAW method are by sorting the largest numbers to the smallest. The result of the ranking with SAW method, the best alternative is alternative 7 (A7) and alternative 4 (A5) with the same score of 76.55. For further research may try to use another algorithm like AHP or Apriori.

REFERENCES

[1] N. I. Muswara, Mujidin, and Purwadi, "Peran Efikasi Diri dan Dukungan Sosial Dosen Pembimbing Skripsi Terhadap Prokrastinasi Menyelesaikan Skripsi Pada Mahasiswa," in

Prosiding Seminar Nasional Magister Psikologi Universitas Ahmad Dahlan, 2019, pp. 37–45.

[2] N. Andriani and B. Wibawanta, "Peran Dosen Pembimbing Sebagai Pemimpin yang Melayani Dalam Pembimbingan Tugas Akhir Mahasiswa Program Sarjana [The Role of Supervisor as a Servant Leader in The Final Project Supervision of Undergraduate Students]," *Polyglot J. Ilm.*, vol. 16, no. 2, pp. 230–251, 2020.

[3] U. Rizki, A. M. Zuhdi, and Kusriani, "Sistem Pendukung Keputusan Dengan Metode Naive Bayes Untuk Pemilihan Dosen Pembimbing," *J. Inf. J. Penelit. dan Pengabd. Masy.*, vol. 5, no. 2, pp. 65–72, 2019.

[4] Y. Palopak and Z. Lumbantobing, "Analisa dan Perancangan Sistem Informasi Pendukung Keputusan Berbasis Web untuk Pemilihan Penghuni Asrama UNAI Menggunakan Metode SAW," *J. Telka Teknol. Inf. dan Komun.*, vol. 9, no. 1, pp. 1–13, 2019.

[5] S. Janti, M. Adriansyah, and G. Taufik, "Simple Additive Weighting for Decision Support Selection of Expedition Services," *Sink. J. dan Penelit. Tek. Inform.*, vol. 4, no. 2, pp. 115–122, 2020.

[6] H. D. Permatasari, Widodo, and B. P. Adhi, "Pengembangan Sistem Pendukung Keputusan untuk Mengetahui Kecendrungan Seorang Mahasiswa Dalam Mengambil Mata Kuliah Pilihan Dalam Lingkup Pendidikan Teknik Informatika dan Komputer Menggunakan Algoritma Apriori," *J. Pinter Pendidik. Tek. Inform. dan Komput.*, vol. 4, no. 2, pp. 1–5, 2020.

[7] S. Fadli, M. Ashari, H. Asyari, and A. S. Pardiansyah, "Implementation of the AHP-SMARTER Method in the Decision Support System for Giving Sanctions for Violation of Student Disciplines," *JISA (Jurnal Inform. dan Sains)*, vol. 5, no. 1, pp. 1–11, 2022.

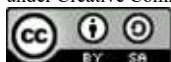
[8] Supriatin, A. R. Saputra, and B. Satria, "Implementation of Aras Algorithm on Decision Support System to Determine The Best Lecturer," *JITK (Jurnal Ilmu Pengetah. dan Teknol. Komputer)*, vol. 8, no. 1, pp. 25–32, 2022.

[9] N. Setiawan *et al.*, "Simple Additive Weighting as Decision Support System for Determining Employees Salary," *Int. J. Eng. Technol.*, vol. 7, no. 2.14, pp. 309–313, 2018.

[10] M. R. Firdaus and N. Nuraeni, "Pemilihan Laptop Terbaik Menggunakan Metode Simple Additive Weighting," *JIKO (Jurnal Inform. dan Komputer)*, vol. 6, no. 2, pp. 218–222, 2022.

[11] R. A. Saputri, A. N. Sianturi, S. Mutmainnah, and E. R. Yulia, "Sistem Penunjang Keputusan Penerimaan Karyawan Baru Menggunakan Metode Simple Additive Weighting (SAW) Berbasis Web Pada PT Crestec Indonesia Cikarang," *JIKO (Jurnal Inform. dan Komputer)*, vol. 6, no. 2, pp. 207–217, 2022.

[12] H. Adela, K. A. Jasmi, B. Basiron, M. Huda, and A. Maselena, "Selection of Dancer Member Using Simple Additive Weighting," *Int. J. Eng. Technol.*,



- vol. 7, no. 3, pp. 1096–1097, 2018.
- [13] I. J. T. Situmeang, S. Hummairroh, S. M. Harahap, and Mesran, “Application of SAW (Simple Additive Weighting) for the Selection of Campus Ambassadors,” *Int. J. Informatics Comput. Sci.*, vol. 5, no. 1, pp. 21–28, 2021, doi: 10.30865/ijics.v5i1.2847.
- [14] N. M. Nasir and N. A. M. Ali, “The Development of An Augmented Reality Technology Application Using Addie Model on Packaging,” *Int. J. Accounting, Financ. Bus.*, vol. 7, no. 41, pp. 209–218, 2022, [Online]. Available: www.ijafb.com
- [15] Y. Hanafi, N. Murtadho, M. A. Ikhsan, and T. N. Diyana, “Reinforcing Public University Student’s Worship Education by Developing and Implementing Mobile-Learning Management System in the ADDIE Instructional Design Model,” *Int. J. Interact. Mob. Technol.*, vol. 14, no. 2, pp. 215–241, 2020.
- [16] R. Arief, M. I. Wazirudin, A. Rachman, and D. P. Hapsari, “Pengembangan Aplikasi Pembelajaran TIK Berbasis Web Menggunakan Model ADDIE Untuk Siswa SMK,” in *Seminar Nasional Sains dan Teknologi Terapan VI*, 2018, pp. 509–514.
- [17] M. R. Ramadhan, M. K. Nizam, and Mesran, “Penerapan Metode SAW (Simple Additive Weighting) Dalam Pemilihan Siswa-Siswi Berprestasi Pada Sekolah SMK Swasta Mustafa,” *TIN Terap. Inform. Nusant.*, vol. 1, no. 9, pp. 459–471, 2021.



Implementation Internet of Things for Feeding Catfish Water Quality Analysis Using Linear Regression and K-Nearest Neighbor

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Abstract— Cultivation of catfish (*Clarias Gariepinus*) is a promising business field and also a very productive activity because public interest in catfish is high. This factor is observed by market demand for catfish which is increasing from year to year. In catfish farming, you must pay attention to the acidity of the water (pH), temperature, and oxygen levels, which can change if too much feed is given. This can cause catfish seedlings to die and affect the catfish harvest. Catfish farmers often provide excessive food which causes many catfish seeds to die. This research will conduct a study on an Internet Of Things technology that can be used to monitor the acidity level in water pH, temperature, and oxygen levels as well as feed fish. The Internet of Things is very influential for monitoring the quality of catfish ponds by distributing information data resulting from sensor monitoring. The data obtained will be predicted for water quality in the pond by implementing a Linear Regression method. Furthermore, the acquisition of data from the predictions that have been carried out will be processed again to go to the next phase, namely classifying with the K-Nearest Neighbor algorithm method to carry out the identification phase of water types based on the nearest neighbors. This prediction is used to anticipate and notify catfish farmers through applications if there is a water acidity level (pH), temperature, and oxygen and feed levels that have run out.

Keywords— Water Quality Analysis, Internet of things, K-Nearest Neighbor

I. INTRODUCTION

Cultivation of catfish (*Glarias Gariepinus*) is a very productive activity because public interest in catfish is high. In helping the success in the cultivation of catfish farm, good management is needed. Various attempts have been made to develop [1]. One of the main factors involved in cultivating catfish is feeding regularly, because it greatly affects the growth of the catfish itself. Excess feed (overfeeding) can lead to various adverse effects including faster growth of catfish seedlings at the beginning of cultivation, reduced capacity and quality in soil and water, as well as disease infection and can cause many catfish seedlings to die. While the lack of feed (underfeeding) low can result in disruption of growth in catfish seedlings. The two factors above can affect the yield of the catfish, therefore technological developments are very important and have a very good impact on these problems. Technology comes from a manual system which then operates and develops rapidly and increases towards an automated and integrated system [2]. The catfish pond in Mundusari Village, Subang Regency, West Java has a length of 3 meters and a width of 2 meters, and has a water depth of about 50 cm. The quality of pond water for catfish farming can be reviewed in various sources such as river water, then lakes, the effect of feed given to fish and wells. In catfish pond cultivation in Mundusari Village, Subang Regency, West Java, two types of

feed are given to the catfish, namely pellets as the main feed and tiren chicken when the fish farmers are experiencing a decline in economic conditions. In addition to the various kinds of water, rainwater can also be used in catfish farming, but due to the high acidity and cold temperatures, separate treatment must be obtained before being used for cultivation. Water for the development of catfish should not be contaminated by various kinds of waste, because it will have an impact and endanger the life of the catfish. The quality of the water in the catfish pond must be considered and the qualifications for catfish cultivation include clear color and not polluted. The balance of pH levels in water is the most important tip to become a good predictor of catfish cultivation benchmarks. It is very mandatory in catfish cultivation to maintain the stability of the pH of the water with levels of 5.5 - 7.5. The condition of the pH of the water can be said to be neutral if it is in the pH level of 6-7, if the condition of the water is in the pH range above 7 then the water is in the alkaline category, if the pH level of the water is below 6 then the water is in the acidic category. In acidic conditions, fungi and bacteria will grow and multiply, catfish have resistance at pH level conditions of 5.5 – 7.5. Water with an environment that does not meet the stated criteria can create a source of disease which in the future can endanger the growth of the catfish [3]. These factors can be implemented by monitoring the condition of the pH level of the fish pond using the use of an internet of things technology. In taking the data it is necessary to obtain an information on the condition of the pH



level in the catfish pond. The Internet of Things is a series of objects in the form of hardware that can exchange information, both service operators and other devices that have been connected to a system until finally they can provide greater impact. The results from these sensors will be used to predict the quality of pool water within the next 14 days, in predicting the quality of the pool water, a method is needed, while the method used is Linear Regression [4]. The application of the system to the K-Nearest Neighbor method is by comparing the data that has been tested and the data that has been trained on the database [5]. Based on these problems, a study was conducted to create a feeding system for catfish and analyze water quality based on temperature, pH, and also ammonia in the water by applying a Linear Regression and K-Nearest Neighbor method based on Smart Mobile Internet Of Things. The results of this study are expected to help farmers in preventing the death of catfish seedlings in the context of cultivating catfish.

II. RESEACRH METHODOLOGY

The methodology used in this research consists of several stages. This stage will predict and also detect water quality in the catfish pond based on the pH level of the water, temperature, and ammonia.

A. Data Acquisition

The data acquisition process is collecting data values from the device to display the data information obtained. The data acquisition system in this study obtains data from IoT devices by using temperature sensors, pH sensors and ammonia sensors. The location used for data collection is Pamanukan Catfish Farm, Subang Regency. The working process of the data collection system on the IoT weather station tool is shown in Figure 2 below :

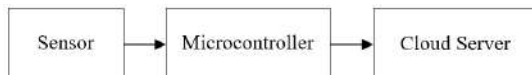


Fig. 1. Work Process.

In Figure 1 above is the working process of the data acquisition system on the IoT water acidity (pH) sensor tool which is used to obtain data results as information. Each sensor device takes data consisting of 3 objects, namely temperature, pH and ammonia. The data obtained will go to the Rasberry Pi to be sent to the Cloud Server as a data storage container. Data consisting of temperature, air humidity and soil moisture obtained through sensors will be displayed on the website, then the website display will be changed to mobile. In this mechanism, data can enter the stage of the forecasting process.

B. Forecasting

Linear regression is also a statistical method whose function is to test the degree between the causal factor (x) and the outcome variable. The

causal factor is usually represented by X , and the outcome variable is represented by Y . Simple linear regression or commonly abbreviated as SLR (Simple Linear Regression) is also one of the statistical methods used to predict or predict the quality and quantity characteristics in production. The general equation for the simple linear regression method in this study can be seen in the equation 1 model below [6]:

$$Y = a + bX \quad (1)$$

The coefficients of equations a and b can be determined using the least squares method. The least squares method is a method for determining the coefficients of an equation. Is the smallest value obtained from the sum of the squares between the points with the smallest regression line that can be searched. Therefore, the application of the model in the above equation is carried out to determine the value of an effect variable (y). After that, to find a coefficient value (b), a formulation model is needed which can be seen in the model equation 3.2, which is as follows:

$$b = \frac{n \sum x_i y_i - \sum x_i \sum y_i}{n \sum x_i^2 - (\sum x_i)^2} \quad (2)$$

The application of the model in the above equation is carried out to obtain a coefficient value (b), namely n = total data (sum x multiplied by number of variables y) - (sum x) multiplied (number of variables y) / overall data (n) multiplied by (sum x times the number of x) - (sum of x)² [7]. In the next step to find the value for constant (a) a formula is needed in the model equation 3.3 as follows:

$$a = \frac{\sum y}{n} - \frac{b \sum x}{n} \quad (3)$$

The application of the model in the above equation is carried out to obtain a constant value (a), which is the total number of variables y - the result of the coefficient value (b) multiplied by the total number of variables x and divided by the number of data (n). The steps for carrying out calculations on a simple linear regression are as follows:

- 1) Determine a causal factor variable (x) and an effect variable (y) on a data.
- 2) Compile the data that will be used as the causal factor variable (x) and the effect variable (x).
- 3) Accumulating related data.
- 4) Performs a calculation to find a value on the variables x_2 , y_2 , xy value, and the whole of each.
- 5) Look for the value of the coefficient (b) and the value of the constant (a) based on the formula model equation 3.1 and model equation 3.2 above.

- 6) Create an equation model for simple linear regression by looking for MSE (Mean Squared Error).
- 7) Carry out a prediction implementation with the error percentage obtained on the causal factor variable or the effect variable [8].

Based on the description above, a flow diagram is obtained to carry out the process of forecasting stages, which aims to determine the predicted value for the next 14 days by collecting variable data obtained from Internet of Things tools. The next step is to find a value of x_2 which is designed to find the value of the independent variable and find the value of the dependent variable of x and y . After looking for this value, the next step is to find the value of the constant (a) and the value of the coefficient (b). If the value has been obtained, a search for the predicted value and MSE (Mean Squared Error) value will be carried out. After that, the next process is to find the predicted value for the next 14 days. The data obtained from the Internet of Things tool can be seen in Table 1, as below:

TABLE 1. WEATHER TEMPERATURE DATA

Day (x)	Temp (y)	X2	xy
1	27.3	1	27.3
2	27.4	4	54.8
3	27.9	9	83.7
4	28.6	16	114.4
5	28.8	25	144
6	28.7	36	172.2
7	28.3	49	198.1
8	28.8	64	230.4
9	29	81	261
10	29.2	100	292
11	28.9	121	317.9
12	28.9	144	346.8
13	27.6	169	358.8
14	21.6	196	302.4
105	391	1015	2903.8

Table 1 shows that the temperature data obtained will be used as simulation data for linear regression analysis calculations, and will be predicted in the next 14 days or for two weeks based on the amount of data obtained. It can be seen at the end of table x that there is a total of 105, and in the table of temperature (y) there is a total of 391. This number is not the number of days or the temperature that is totaled but a total number of variables x and variable y used for linear regression calculations. The total data is obtained based on the formula for the linear regression equation model, not the total number of day data (x) or temperature data (y). The next step is to find a value of x_2 that will be used to determine a value of b , which is a coefficient variable (x). Regarding the calculation applied, the value of an x will be multiplied by the number itself or the multiplication of the square, then the total number for the x_2 variable is 1015. In the next step, doing a calculation to find a value for the xy variable in the temperature data, the total total is obtained. at xy

value is 2903.8. The next step is to search for a variable coefficient value at x (b) based on the temperature variable using a formula in the following equation 2 model:

$$b = \frac{n \sum x_i y_i - \sum x_i \sum y_i}{n \sum x_i^2 - (\sum x_i)^2} \quad (4)$$

The next step is to search for a constant variable (a) by implementing a formula in equation 3 as shown below:

$$a = \frac{\sum y}{n} - \frac{b \sum x}{n} \quad (5)$$

The next step is to do a search on the linear regression equation based on the temperature variable by implementing a formula listed in the equation 1 model as follows:

$$Y = a + bX \quad (6)$$

After getting the results of the linear regression equation, the next step is to perform calculations to find a prediction. The method used is Root Mean Square Error (RMSE). MSE estimates a prediction method by squaring the error which is then executed by an addition based on the number of observations [9]. This MSE can minimize the biggest prediction error. The formula for the RMSE can be seen in the equation 4 model as follows:

$$RMSE = \sqrt{\frac{\sum_{i=1}^N (y_i - \hat{y})^2}{N}} \quad (7)$$

In the prediction search by looking for the average error based on the equation model above, namely by reducing the predicted value that has been obtained with the actual value [8].

$$RMSE = \sqrt{\frac{\sum_{i=1}^{14} (28.74857143 - 27.3)^2}{14}}$$

Based on the acquisition of the MSE value, a data prediction for the 1st variable (y) is obtained which can be seen in Table 3 as follows: The results obtained for 2 weeks are calculated by applying the formula contained in the equation 1 model as follows:

$$Y = a + bX \quad (7)$$

In the prediction search above, multiplying the day (x) that will be predicted, then the predicted temperature on the 15th day is 26.98. The temperature prediction obtained can be seen in Table 2 as follows:

TABLE 2. RESULT OF PREDICTION EXPERIMENTS

Day	Temperature Forecast
15	26.98
16	26.85
17	26.73
18	26.60
19	26.47



Day	Temperature Forecast
20	26.35
21	26.22
22	26.09
23	25.97
24	25.84
25	25.72
26	25.59
27	25.46
28	25.34

Table 2 is the result of the forecasting stage that will be used for the next 2 weeks based on data on temperature. Obtaining the highest forecasting results is on the 15th day with the acquisition value of 26.98 degrees Celsius.

C. K-Nearest Neighbor (KNN) Classification

K-Nearest Neighbor (K-NN) is a collection of instance-based learning. This algorithm is also an instance-based learning technique. KNN is solved by finding the group of k objects that are closest (similar) to the objects in the new data or test data in the training data. K-Nearest Neighbor can provide benefits and provide good accuracy, so that the recommendations generated according to the needs or interests of users [10]. The K-Nearest Neighbor (KNN) algorithm is a data collection classification method based on previously classified learning data. Included in supervised learning, where the results of new query instances are classified according to the most common categories in KNN. The algorithm determines the KNN based on the shortest distance from the test sample to the training sample. After taking the KNN, most of the KNN will be used as a test sample prediction. Usually, the nearest neighbor or far neighbor is calculated based on the Euclidean distance *Case folding*: a stage to uniform a sentence or text into a standard. Process case folding used so that the system does not process a word that has the same meaning even though the writing pattern is different [11]. The steps for using the KNN method are described as follows:

- 1) Determine the parameter k.
- 2) Calculates the distance between the data to be evaluated with all training data.
- 3) Line up the distance formed (ascending order).
- 4) Determine the closest order k.
- 5) Match the appropriate class.
- 6) Find the number of classes from the nearest neighbor, and set this class as the data class to evaluate [12].

The search for the value of k is determined by the equation model (3.5) as follows:

$$k = \sqrt{n} \quad (8)$$

The application of the above formula equation model is used to determine the value where n is the

number of sample data. The value of k is basically the total of odd numbers in the selection process which serves to prevent the same distance value from occurring. The next stage is data normalization, the Min-Max Normalization formula. Min-max normalization is one of the most common ways to normalize data. For each feature, the minimum value of the feature is changed to 0, the maximum value is changed to 1, and every other value is converted to a decimal between 0 and 1. The application of this method can be seen in the model equation 7 as follows [13]:

$$x * = \frac{x - \min(x)}{\max(x) - \min(x)} \quad (9)$$

Based on the description above, a flow diagram is obtained to perform a classification. The data will be obtained using the K-Nearest Neighbor algorithm method in the classification process to determine the k parameters of the predicted data. After finishing determining the parameters at k and before calculating the distance, what must be done is to find the normalization value of each training data and test data. Preprocessing is an early stage that must be done in data mining. Preprocessing goals in data mining is to prepare data raw before any other process. Preprocess data is done by eliminating data that do not match or change the data into a form that easier to process by the system [14]. The application of the search for normalization values can be done by implementing an equation model (6):

$$x * = \frac{x - \min(x)}{\max(x) - \min(x)} \quad (10)$$

The calculation above is to find the normalization of temperature, water pH, and ammonia in the first training data. The formula is applied according to the total number of training data, which is 14 data. The thing that must be met to find a distance is to find the entire normalization value first. A series of test data obtained through the forecasting stage using the Linear Regression method for the next 14 days. When the search process has been completed, the search results will find out most of the objects obtained by relying on training data and testing data [15]. This series of processes will produce classification results to determine the water quality suitable for catfish farming based on weather predictions and future water quality.

D. Testing

In this process, a system test is carried out by implementing a blackbox method. The application of this method is carried out to ensure that all requirements have been implemented as well as identify deficiencies in the system and provide output that meets the expectations of the examiner by conducting a system accuracy test.

III. RESULT AND DISCUSSION

After analyzing and simulating the design contained in the previous chapter, the results and discussion of the system built were obtained. This is based on the method used in this study, namely Linear Regression and the K-Nearest Neighbor algorithm. The process of sending data contained in Internet of Things devices must comply with a data communication architecture protocol that has been created, namely on an IoT gateway as a message receive from a sensor and continue sending the data to the server. In the next stage, implement the forecasting interface which is a menu display to see the prediction results obtained by displaying the results of the graph of the prediction processing results for each data such as temperature, pH, and ammonia. The graph displays original data and predictive data. There are 2 plots in displaying graphs consisting of forecasting graphs from 1 week data that have been taken from sensor devices. The first plot displays the original data graph and the second plot displays the predicted data graph on the data for the next 1 week. The forecasting mechanism also displays the results of the Mean Squared Error (MSE) value obtained based on each forecasting process from each data. The display of the forecasting temperature interface can be seen in Figure 2 as follows:

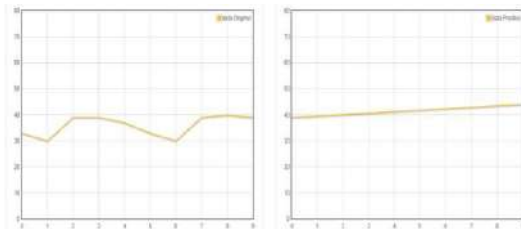


Fig. 2. Linear Regression Temperature Forecasting

Figure 2 shows a forecasting process carried out by a linear regression algorithm, the forecasting was carried out for monitoring weather conditions around the pond and in order to prevent and carry out maintenance on the catfish pond, the forecasting was carried out for 10 days. At the left image show temperature was recorded in 10 days and the right image show trend of forecasting for next 10 days. These means that the average temperature in the next 10 days is between 40 to 50. In the next stage, the forecasting process is carried out using linear regression on the pH of the water, as shown in Figure 3 as follow:

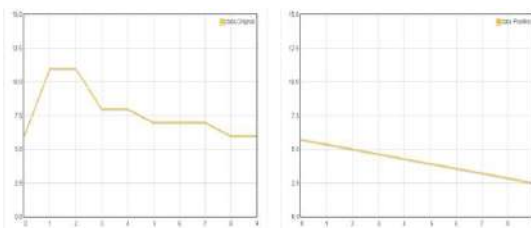


Fig. 3. Linear Regression pH Forecasting

Figure 3 shows a forecasting process carried out by a linear regression algorithm, the forecasting was carried out for monitoring the pH conditions of the water contained in the pond and performing maintenance on the catfish pond, the forecasting was carried out for 10 days. In Figure 3, there is a fairly high increase in data in the original data, namely on day 2 and day 3 on the graph, and experienced a very drastic decrease in the forecasting mechanism. At the left image show pH was recorded in 10 days and the right image show trend of forecasting for next 10 days. These means that average trend of pH decreasing in the next 10 days. In the next stage, the forecasting process is carried out using linear regression on the ammonia gas, as shown in Figure 4 as follow:

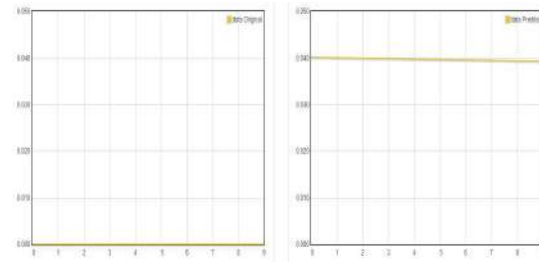


Fig. 4. Linear Regression Ammonia Forecasting

Figure 4 shows a forecasting process carried out by a linear regression algorithm, the forecasting was carried out for monitoring ammonia gas around the water in the pond and performing maintenance on the catfish pond, the forecasting was carried out for 10 days. Ammonia gas usually arises from the remnants of food contained in the pond and also fish waste that is trapped in the pond. The last stage is a classification process that functions as a recommendation for suitable care for catfish using a K-Nearest Neighbor algorithm method. This classification process relies on factual data that has been obtained from the research location. In the next stage, making a classification interface is a display of the results of the classification of recommendations for the type of treatment that is suitable for the fish pond according to the conditions of temperature and humidity, pH, and also levels of ammonia gas. The results of the classification will be sorted so that the earliest treatment is the one that is highly recommended to be carried out in the condition of the catfish pond. The display in the classification process will display each Euclidean Distance obtained. The appearance of the classification interface by implementing the K-Nearest Neighbor Algorithm method can be seen in Table 3 as follow:

TABLE 3. CLASSIFICATION USING THE K-NEAREST NEIGHBOR

No	T	pH	Ammonia	Treatment Type	K-NN results
1	35	11.5	0.012	Waste 50% Water and Replace	1.6143 297322 556016



				50% With New Water	
2	40	7.15	0.022	Waste 50% Water and Replace 50% With New Water	3.1715 916852 23332
3	33	7.15	0.2	Waste 50% Water and Replace 50% With New Water	3.1715 916852 23332
4	35	7.15	0.23	No Treatment	4.0090 805867 56908
5	33	11.7	0.02	No Treatment	4.1959 576361 59408
6	35	6.15	0.012	No Treatment	4.5977 596520 23774
7	41	8.65	1.02	Sprinkle PK medicine and combine it with salt water then dissolve it, and pour it into the fish pond in question	5.8485 947444 18905

In table 3, the system of the K-Nearest Neighbor Algorithm provides a recommended action according to the previous data collection stage, classification is carried out for the next 10 days based on forecasting data performed by the previous Linear Regression Algorithm.

IV. CONCLUSIONS

Linear Regression and K-Nearest Neighbor based on the Internet of Things can be implemented on a website system for water quality analysis and automatic feeding of catfish. The system can retrieve online data that is accessed using the API and displays forecasting graphically from original data and predictive data and presents recommendations for the type of treatment that is suitable for catfish ponds found in Mundusari Village, Subang Regency, West Java. Internet of Things devices can generate data from individual sensors such as DHT11 for temperature, pH sensors, and MQ-2 for ammonia. The data collection process was carried out for 14 days, from 21 July 2021 to 03 August 2021.

REFERENCES

[1] Al-Dosary, N. M. N., Al-Hamed, S. A., & Aboukarima, A. M. (2019). K-NEAREST NEIGHBORS METHOD FOR PREDICTION OF FUEL CONSUMPTION IN TRACTOR-CHISEL PLOW SYSTEMS. *Engenharia Agricola*, 39(6), 729–736.

[2] Priyanka, G., Prakash, N., Kishore, A., & S, N. K. (2020). *Smart IoT Based Fish Pond Monitoring System to Enhance Fish Cultivation*. 29(5), 6408–6417.

[3] Guo, Y., Han, S., Li, Y., Zhang, C., & Bai, Y. (2018). K-Nearest Neighbor combined with guided filter for

hyperspectral image classification. *Procedia Computer Science*, 129, 159–165. <https://doi.org/10.1016/j.procs.2018.03.066>

[4] Hu, G., Yang, Z., Zhu, M., Huang, L., & Xiong, N. (2018). *Automatic classification of insulator by combining k-nearest neighbor algorithm with multi-type feature for the Internet of Things*. 1–10.

[5] Fitriani, R., & Vitriani, Y. (2018). The Comparison of Linear Regression Method and K-Nearest Neighbors in Scholarship Recipient. *2018 19th IEEE/ACIS International Conference on Software Engineering, Artificial Intelligence, Networking and Parallel/Distributed Computing (SNPD)*, 194–199.

[6] Arafat, A. I., Akter, T., Ahammed, F., Ali, Y., & Nahid, A. (2020). A dataset for internet of things based fish farm monitoring and notification system. *Data in Brief*, 33, 106457. <https://doi.org/10.1016/j.dib.2020.106457>

[7] Wahla, A. H., Chen, L., Wang, Y., Chen, R., & Wu, F. (2019). Automatic wireless signal classification in multimedia Internet of Things: An adaptive boosting enabled approach. *IEEE Access*, 7, 160334–160344.

[8] Wang, W., & Lu, Y. (2018). Analysis of the Mean Absolute Error (MAE) and the Root Mean Square Error (RMSE) in Assessing Rounding Model. *IOP Conference Series: Materials Science and Engineering*, 324(1). <https://doi.org/10.1088/1757-899X/324/1/012049>

[9] Chai, T., & Draxler, R. R. (2014). Root mean square error (RMSE) or mean absolute error (MAE)?—Arguments against avoiding RMSE in the literature. *Geoscientific Model Development*, 7(3), 1247–1250.

[10] Kang, S. (2021). K-nearest neighbor learning with graph neural networks. *Mathematics*, 9(8). <https://doi.org/10.3390/math9080830>

[11] Guo, G., Wang, H., Bell, D., Bi, Y., & Greer, K. (2003). KNN model-based approach in classification. *Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, 2888(August), 986–996. https://doi.org/10.1007/978-3-540-39964-3_62

[12] Kurniadi, D., Abdurachman, E., Wamars, H. L. H. S., & Suparta, W. (2018). The prediction of scholarship recipients in higher education using k-Nearest neighbor algorithm. *IOP Conference Series: Materials Science and Engineering*, 434(1). <https://doi.org/10.1088/1757-899X/434/1/012039>

[13] Nababan, A. A., Sitompul, O. S., & Tulus. (2018). Attribute Weighting Based K-Nearest Neighbor Using Gain Ratio. *Journal of Physics: Conference Series*, 1007(1). <https://doi.org/10.1088/1742-6596/1007/1/012007>

[14] Prasath, V. B. S., Alfeilat, H. A. A., Hassanat, A. B. A., Lasassmeh, O., Tarawneh, A. S., Alhasanat, M. B., & Salman, H. S. E. (2017). *Distance and Similarity Measures Effect on the Performance of K-Nearest Neighbor Classifier -- A Review*. 1–39. <https://doi.org/10.1089/big.2018.0175>

[15] Taunk, K., De, S., Verma, S., & Swetapadma, A. (2019). A brief review of nearest neighbor algorithm for learning and classification. *2019 International Conference on Intelligent Computing and Control Systems (ICCS)*, 1255–1260.



Development of Mail Archive Management Information System at Lombok Tengah District Education Office

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Abstract – The Mail Archive Management Information System at the Lombok Tengah Education Office was created for the effectiveness and efficiency of storing or managing incoming mail archives and outgoing mail archives at the Education Office. Management of mails that still use the manual method, namely by storing mail archives on folders, makes frequent errors in storage such as: loss of mails, tearing of mails and so on, as well as errors in recording and the duration of data searching. This Mail Archive Management Information System was designed and built using the waterfall method and MVC (Model View Controller) as the programming method, this information system is web-based, created using the PHP framework, namely CodeIgniter, HTML, Javascript, and CSS. As for the server, it uses a default Codeigniter local server. The management of the mail archives generated by the system is able to speed up the data searching process and is able to monitoring the amount of incoming mail, outgoing mail and the number of users using the system.

Keywords – Archive Management, Codeignite, Information System, Mail.

I. INTRODUCTION

Computerized archive management has now become a much-needed choice for both government and private agencies. Because it can streamline storage space, facilitate data collection, facilitate search and monitoring and reporting of archives [1]. Archives are a source of information which certainly has an important role in the survival of the company because archives have a variety of information that can be used as evidence of accountability or as a supporting tool in making a decision [2]. At the Central Lombok Regency Education Office, which is a government agency that uses the computer only in certain parts, one of the most important information in an institution is data from the agency's activities, this data is contained in the archives. One of the problems faced by the Central Lombok District Education Office includes filing letters, where the system for recording incoming and outgoing letters and the disposition of letters still uses a manual process, as a result it is difficult to find the archives needed for the process of carrying out its activities, causing miscommunication. and duplication of archives that hinders the smooth running of work activities [3]. One of the tasks of the incoming and outgoing mail filing section is to manually compose received and issued letters. Therefore a letter filing system is needed to overcome problems in terms of recording incoming and outgoing letters, the computerized recording process can record errors or mistakes that occur, so that data accumulation does not occur and searching for the necessary data will be very important. easy to find when it has been computerized [4].

Through this Letter Archiving Information System it is hoped that it will make it easier for government agencies of the Central Lombok District Education Office to run more optimally. Having an information system that

is able to manage projects successfully and efficiently is very important for agencies and businesses [5].

In accordance with Article 4 of the Lombok Tengah Regency Regulation Number 72 of 2021, the education office in Lombok Tengah Regency has the following responsibilities: formulation of policies, plans, programs and budgets in the fields of basic education, early childhood education and non-formal education, fostering educators and education personnel, as well as the field of educational facilities and infrastructure. Outgoing and incoming mails, as well as filing methods (which are still done by hand and stored in a folder). all of them are closely linked in a government agency such as the Lombok Tengah Education Office. As a result, old mails are not neatly arranged [6].

Based on this description, the development of a Mail File Management Information System is very possible, because it will enable effective data storage and retrieval [7]. Therefore, an archival information system has been developed that makes it easier to find archives when needed. No doubt again [8].

II. RESEARCH METHODOLOGY

A. Information System

Organizations use information systems to collect and distribute information internally and externally using a variety of technologies and processes [9].

According to [10] there are 7 functions of information systems, namely:

1. To make current data more accessible to consumers without the need for additional information systems.
2. Improve productivity of application development and system maintenance.
3. Ensure that quality and expertise in essential uses of information systems are available. Mengidentifikasi kebutuhan mengenai keterampilan pendukung sistem informasi.



4. Anticipating and understanding the economic consequences.
5. Determine the investment to be directed at the information system.
6. Develop an effective planning process.

B. Application and System Software Modeling

In Tohari's view, "fashioning is a simplification of a problem. As a visualization and communication medium between the many parties involved in the creation of a system or application software, modeling serves as a useful tool in the context of system development or application software [11]. Unified Modeling Language (UML) is a standard specification language used to define, design, and develop software [12].

C. Visual Studio Code

According to [13], "Visual Studio Code (VS Code) is a lightweight and reliable text editor designed by Microsoft for multi-platform operating systems, which means it is also available for Linux, Mac, and Windows versions." In addition, this text editor can be used to write code in additional programming languages that can be installed via the Visual Studio Code market (such as C++, C#, Python, Go, Java, etc.) in addition to JavaScript and TypeScript. Visual Studio Code comes with many tools to enhance text editor functionality, including Intelisense, Git Integration, Debugging, and Extensions. It will continue to evolve after the Visual version itself is".

D. Framework

A framework is a set of ready-made functions or methods and classes for a specific purpose that a programmer can use without having to build new functions or classes from scratch [14].

According to [14] there are 4 reasons why you should use a framework:

- a. Simplify and speed up the development of a web application.
- b. Because there is already a certain pattern in a framework (provided that the programmer follows the existing standard pattern) it is relatively easy for the maintenance process.
- c. Usually the framework has provided the facilities commonly used so that we don't need to build from scratch (eg validation, scaffolding, ORM, pagination, error handling, session settings, multiple databases, etc.).
- d. When compared to CMS, the use of frameworks is more free in development.

E. MVC (Model View Controller)

Since its introduction in the SMALL TALK programming language, MVC (Model View Control) has become a prominent idea in web application development because it isolates application creation into many aspects that go into its construction, such as the user interface, data processing, and the part that controls the application [15]. State that the application MVC policy consists of three components, as follows [15]:

- a. View is the part of the application that handles the view logic. When using HTML, this area is often only

accessible through the controller. To see what is happening with the application, use the View command. Fetch data from user and display it. Direct access to the model area is not available to users of this section. For manipulating data (inserts, updates, deletions, searches), as well as validation of controllers, model relies on relationships with databases as opposed to the view part.

- b. In this case, the controller is responsible for coordinating between the model and the view part of the application. The controller receives requests and data from the user to decide what the program will handle.

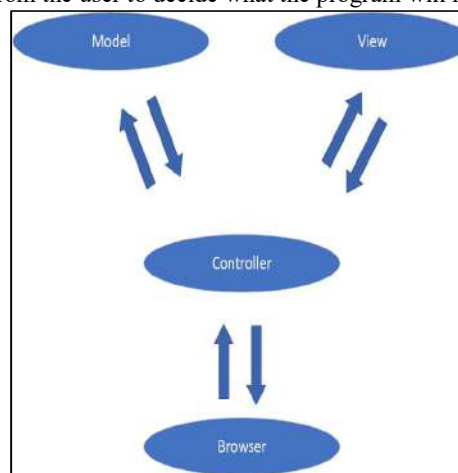


Figure 1. An overview of the MVC process flow (Source: [15])

F. Method of Collecting Data

The writer uses observation and interview methods in collecting data.

a. Observation

Collecting data or information by making direct observations by going directly to the field [16] (Office of the Education Office of Lombok Tengah Regency) on 07 February 2022-31 March 2022.

b. Interview

Data collection was carried out through direct interviews with officials from the Education Office of Lombok Tengah Regency, among others, Bpk. Harsono, S.pd, MM, functional employee in the Planning Division. As a consequence of this, reliable results can be achieved and appropriate sources of information can be accessed [17].

G. Analysis Method

To perform design analysis, the researcher used the PIECES method. James Wheterbe defines that the pieces method is an analysis of performance, information, economics, control, efficiency and service [18]. Where the author conducts a design analysis with indicators:

a. Performance

More effective and efficient than the current system, namely the manual system.

b. Information

Easier access to information

c. Economic

With this mail filing system, the cost of carrying out activities is cheaper.

d. Control

- With this system, users are more flexible in controlling the data that has been archived
- e. *Efficiency*
With this system, mail data is stored more effectively and data retrieval becomes more efficient.
 - f. *Service*
Makes it easier to complete work.

H. *Object of Research*

The object of research being studied is the Official Mail Archive at the Education Office of Lombok Tengah Regency.

III. RESULTS AND DISCUSSION

A. *System Design Method*

Lack of complex features and fewer development restrictions. In other words, the Waterfall technique is the design paradigm used here [19]. Waterfall is a systematic and sequential technique that begins with the advancement of the system through analysis, design, coding, testing, development, and maintenance" says [10] [20].

B. *System Design*

In particular, the Lombok Tengah Education Office uses use case diagrams, activity diagrams, and class diagrams as part of the design and development of a Mail Archive Management Information System [21] [22].

C. *Use Case Diagram*

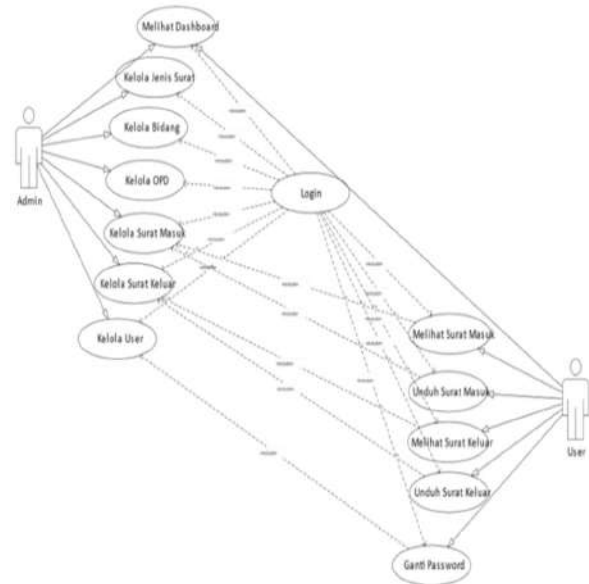


Figure 2. Use Case Diagram.

There are 2 actors in the use case diagram, which are in table 1.

Table 1. Tabel actor in use case

Actor	Explanation
Admin	Admin has access rights to view dashboard, manage mail types, manage fields, manage OPD, manage incoming mail and manage outgoing mail
User	Users have access rights to view dashboards, change passwords, download incoming mail, view incoming

Table 1. Tabel actor in use case

	mail, view outgoing mail and download outgoing mail.
--	------------------------------------------------------

The explanation of each use case specification is described in table 2.

Table 2. Use specification case.

Use Case	Explanation
View Dashboard	View dashboard, on the dashboard there is a graph of outgoing and incoming mail by year. This feature can be accessed by all ROIe.
Manage Mail Type	Manage Mail Type include viewing, adding, changing and deleting mail type data. This feature cannot be accessed by users with other than admin roles.
Manage Fields	Manage Fields includes viewing, adding, editing and deleting field data. This feature cannot be accessed by users with other than admin roles.
Manage OPD	Manage OPD includes viewing, adding, editing and deleting field OPD data. This feature cannot be accessed by users with other than admin roles.
Manage User	Manage user includes viewing, adding, editing and deleting field user data. This feature cannot be accessed by users with other than admin roles.
Manage Incoming Mail	Manage incoming mail includes viewing, adding, editing and deleting field incoming mail data. This feature cannot be accessed by users with other than admin roles except viewing and downloading..
Manage Outgoing Mail	Manage outgoing mail includes viewing, adding, editing and deleting field outgoing mail data. This feature cannot be accessed by users with other than admin roles except viewing and downloading.

D. *Class Diagram*

Class diagram is a diagram that illustrates the connection between classes and also the object classes that make up the system. From this explanation, it can be concluded that the class diagram is a diagram that describes the structure of the system object [23].

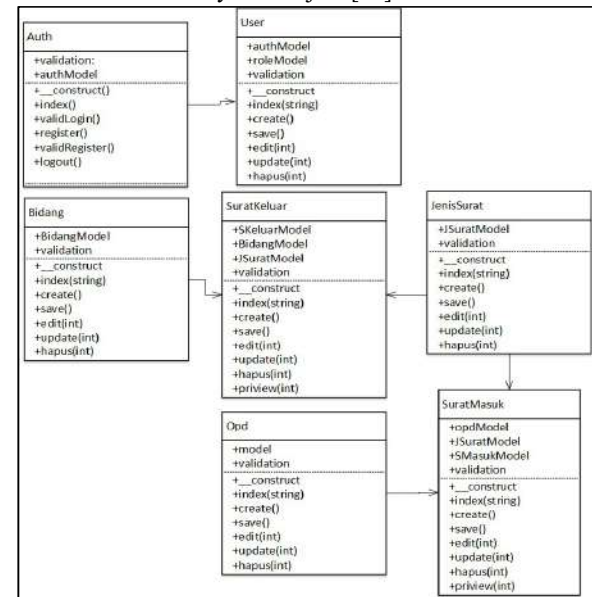


Figure 3. Class diagram.



E. Sequence Diagram

1. Login
2. Login adminan user

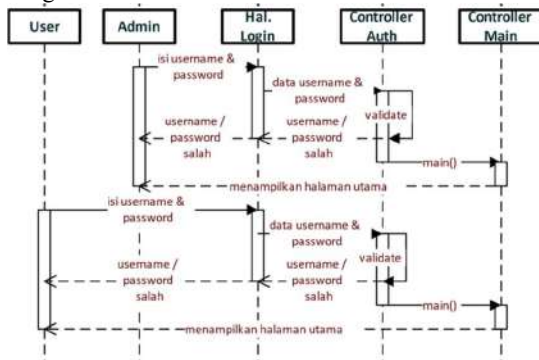


Figure 4. Sequence diagram login.

In figure 4. Describes the admin flow Login to the system.

3. Mail Type Features

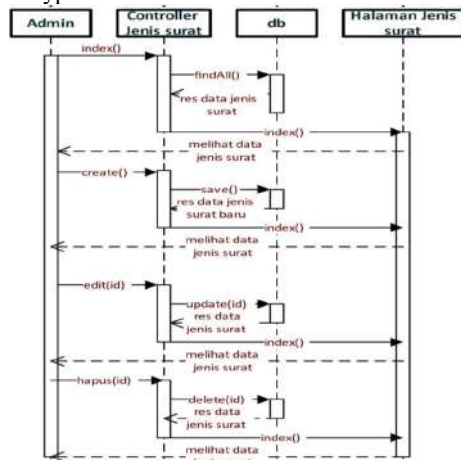


Figure 5. Admin mail type sequence diagram

Figure 5 describes the admin managing mail type data.

4. Field Features

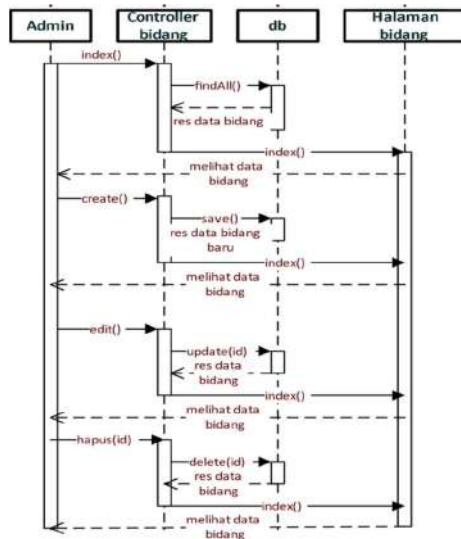


Figure 6. Field features sequence diagram

Figure 6 illustrates the flow of admin managing field data.

5. OPD Features

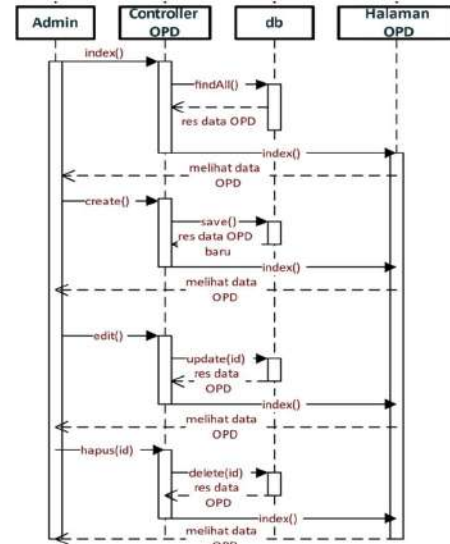


Figure 7. OPD features sequence diagram

Figure 7 illustrates the flow of admin managing OPD data.

6. User Features

- a. Admin manages user data

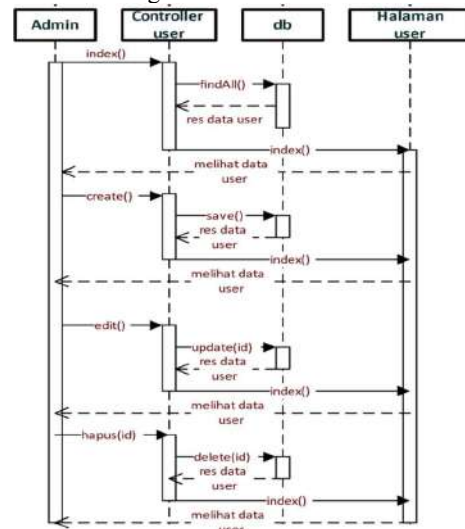


Figure 8. Admin manages user data sequence diagram

In Figure 8, it illustrates the flow of admin managing user data

- b. User manages password

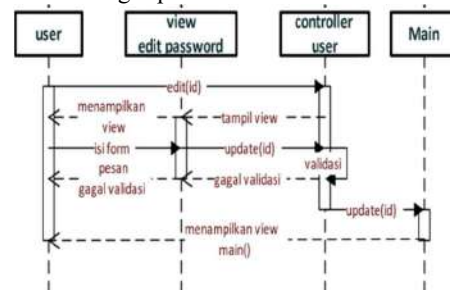


Figure 9. Editing user password sequence diagram

In Figure 9, illustrates the flow of a user changing or editing a password.



7. Incoming mail features

a. Admin manages incoming mail

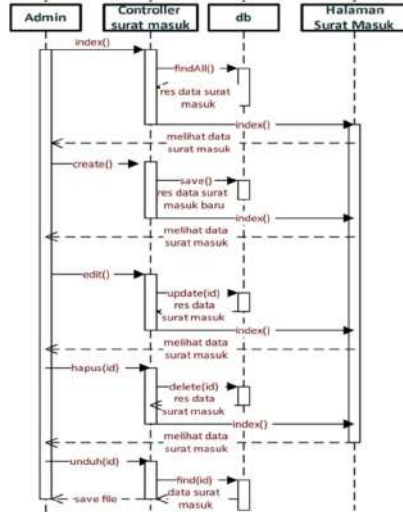


Figure 10. Manage incoming mail Sequence diagram

Figure 10 illustrates the admin flow managing incoming mail data.

b. Incoming mail feature on the user side



Figure 11. View and download incoming mail on the user side sequence diagram

In Figure 11, it illustrates the flow of users viewing and downloading incoming mail.

8. Outgoing mail features

a. Admin manages outgoing mail

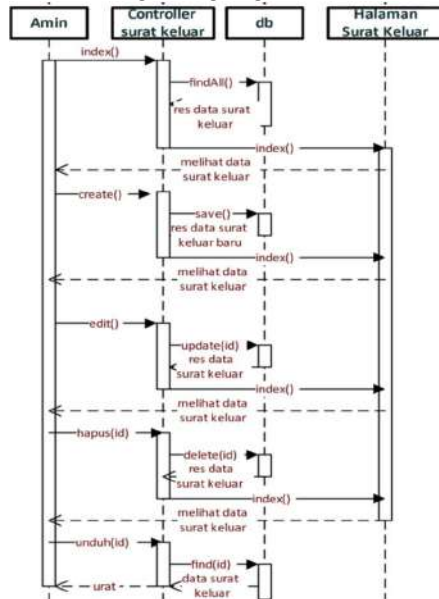


Figure 12. Admin manages outgoing mail Sequence diagram

Figure 12 depicts the admin flow managing outgoing mail data.

F. Relationship Diagram

As for the relationship diagram on the database of the Management Information System for the Mails of the Lombok Tengah Education Office.

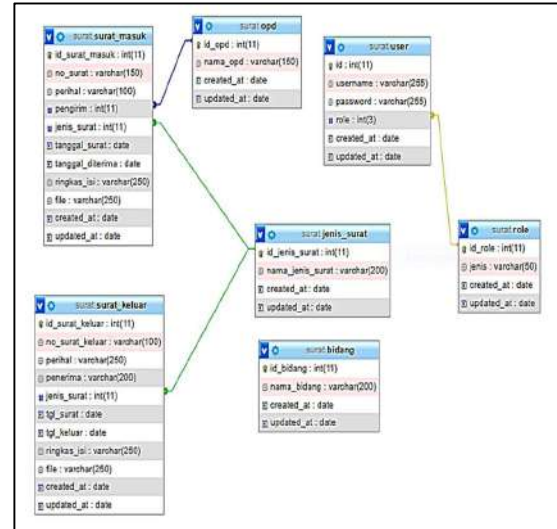


Figure 13. Relationship diagram of the Lombok Tengah Education Office Mail Management Information System.

Figure 13 illustrates that there are 6 related tables. The incoming mail table is related to the opd table and the mail type table. Then tabel user with table role. Outgoing mail table with mail_type table.

G. System Interface

The following is a view of the system interface that has been created using the Codeigniter framework.

1. Login page



Figure 14. System login page.

Before the user can access the system, the user must first login by filling in the login form that has been provided.

2. Dashboard page

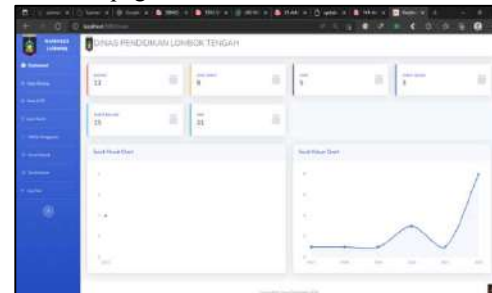


Figure 15. System dashboard page

After the user logs in, the system will direct the dashboard page. Where this dashboard page will display data on the number of incoming mail, outgoing mail, users, etc. As well



as displaying a graph of the number of outgoing and incoming mails per year.

3. Field data page

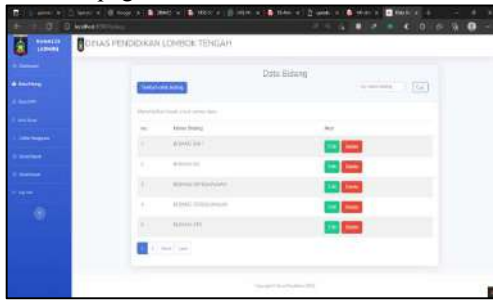


Figure 16. Field data page.

This field data page displays field data at the Lombok Tengah Education Office.

4. Add field form

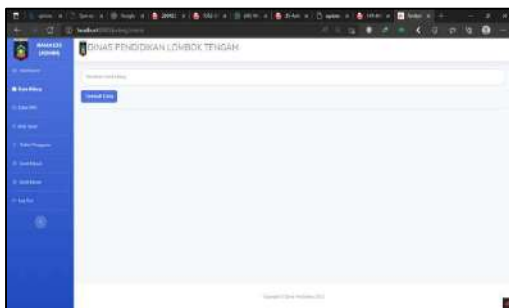


Figure 17. Add field form.

The add field form page is used to add field data.

5. User list page

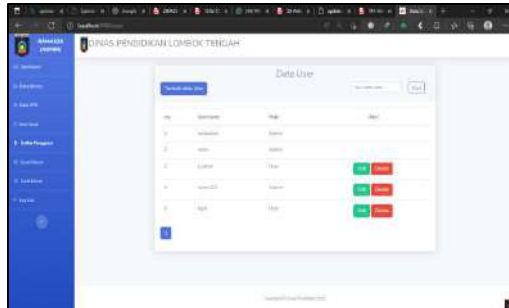


Figure 18. User list page.

This list page displays user data that is on the system.

6. Add user form page

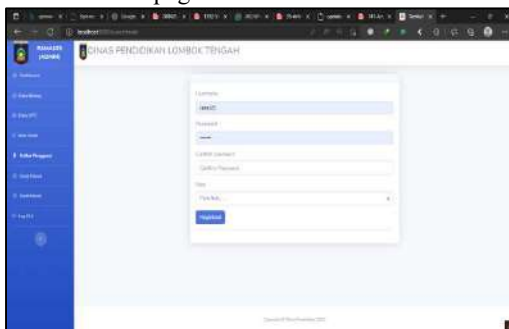


Figure 19. Add user form page.

The add user form page is used to add user data to the system.

7. Incoming mail list page

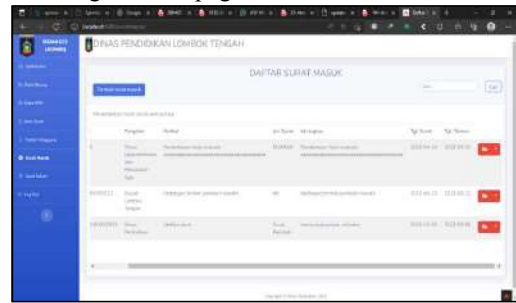


Figure 20. Incoming mail list page.

Incoming mail list page where this page is used to display incoming mail data.

8. Add incoming mail form page

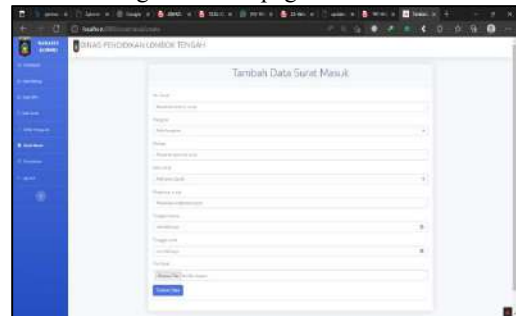


Figure 21. Add incoming mail form.

Where is the added login form page used to add incoming mail archivedata.

9. Outgoing mail list page

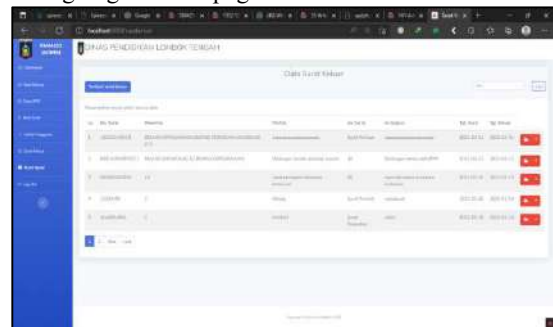


Figure 22. Outgoing mail list page.

Outgoing mail list page is a page used to display outgoing mail data.

10. Add outgoing mail data page

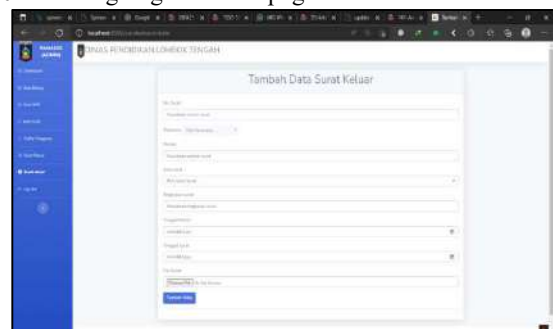


Figure 23. Add outgoing mail page.

The Add Outgoing Mail Data page is the page that is used to add outgoing mail data.

IV. CONCLUSION

Based on the results of the presentation, several conclusions were obtained, among others: From the observation, there are deficiencies in the management system for filing mails at the Education Office of Lombok Tengah Regency, therefore the author has designed a Mail Archives Management Information System which can be an alternative to the Mail Archive Management Information System at the Education Office of Lombok Tengah Regency. The system that has been created is capable of managing mail documents in PDF format with a maximum size of 10 Mb. This mail archive management information system can manage data such as: displaying data, adding data, editing data, downloading data and deleting data, so that it can manage data properly and efficiently. The system can perform searches so as to speed up the search for the desired data.

REFERENCES

- [1] Anisah et al., "Rancang Bangun Sistem Informasi Manajemen Arsip Digital," *Jurnal SISFOKOM (Sitem Informasi dan Komputer)*, vol. 10, no. 3, pp. 419-425, Desember 2021.
- [2] I Sontana, A Rahmatulloh, and A, N Rachman, "Application Programming Interface Google Picker Sebagai Penyimpanan Data Sistem Informasi Arsip Berbasis Cloud," *Jurnal Nasional Teknologi dan Informasi*, vol. 5, no. 1, pp. 25-32, 2019.
- [3] N Haniah and A Ardi, "Rancang Bangun Sistem Pengarsipan Surat pada Kantor DPRD Kota Banjarmasin Berbasis WEB Menggunakan Framework Codeigniter," *Phasti J. Tek. Inform. Politek. Hasnur*, vol. 5, no. 2, pp. 36-40, 2019.
- [4] W Pamulasari and N Suryana, "Rancang Bangun Sistem Informasi Manajemen Surat Berbasis WEB pada Kantor BPJS Ketenagakerjaan Cabang Sukabumi," *Jurnal ENSAINS*, vol. 3, no. 1, pp. 34-41, 2020.
- [5] Ahmad Faisal and Nurul Khairina, "Sistem Informasi Administrasi Surat Masuk Dan Surat Keluar Pada Dinas Pendidikan," *REMIK (Riset dan E-Jurnal Manajemen Informatika Komputer)*, pp. 267-275, 2020.
- [6] Muhammad, Syahrul Imron and Tri Listyorini, "Sistem Manajemen Arsip Surat Berbasis Web di Dinas Pendidikan dan Kebudayaan Pati," in *Seminar Nasional Inovasi Vokasi*, Jakarta, 2022, pp. 136-145.
- [7] Nur, Aprilia Syafitri, Achmad Fauzi, and Ghanistantiono Dwi, "Sistem Informasi Manajemen dan Tata Kelola Surat Menyurat pada Akademi Keperawatan Pasar Rebo Berbasis Website," *Jurnal Sistem Informasi Bisnis (JUNSIBI)*, vol. 3, no. 1, pp. 33-39, April 2022.
- [8] Fitria Rahmadayanti, Jeri Lorenza, and Yogi, Isro Mukti, "Aplikasi Management Surat pada Dinas Kesehatan Kota Pagaralam Menggunakan Codeigniter," *Jurnal Ilmiah Betrik (Besemah Teknologi Informasi dan Komputer)*, vol. 11, no. 2, pp. 108-115, Agustus 2020.
- [9] Trio Rukito, Didit Suhartono, and Nurfaizah, "Sistem Informasi Pengolahan Arsip (Studi Kasus: Dinas Pendidikan Dan Kebudayaan Kabupaten Cilacap)," *Jika (Jurnal Informatika) Universitas Muhammadiyah Tangerang*, vol. 4, no. 3, pp. 78-86, November 2020.
- [10] Romindo Romindo, "Sistem Informasi Pengarsipan Pada Kantor Notaris Efrina Nofiyanti Kayadu, Sh.M.Kn Berbasis Web Dengan Metode Waterfall," *REMIK: Riset Dan E-Jurnal Manajemen Informatika Komputer*, vol. 3, no. 2, pp. 81-86, April 2019.
- [11] Novemli Firdaus and Dedy Irfan, "Rancang Bangun Sistem Informasi Arsip Berbasis Web Menggunakan Framework Codeigniter," *Jurnal Voteteknika*, vol. 8, no. 1, pp. 43-52, Maret 2020.
- [12] Wahyu Suratman, Fauziah Fauziah, and Ratih Titi Komala Sari, "Aplikasi Elektronik Arsip (E-Arsip) Surat Berbasis Web Menggunakan Metode First In First Out (FIFO)," *Paradigma*, vol. 23, no. 2, pp. 125-132, September 2021.
- [13] Puja Irawan, Dimas, Aulia, Pudjie Prasetya, and Petrus Sokibi, "Rancang Bangun Sistem Pengarsipan Surat Kedinasan berbasis Web Menggunakan Framework Codeigniter," *MISI (Jurnal Manajemen Informatika & Sistem Informasi)*, vol. 3, no. 2, pp. 157-165, Juni 2020.
- [14] "Sistem Pengelolaan Arsip Surat Masuk Dan Keluar Berbasis Client Server Studi Kasus: SMK Negeri 1 MANDIRAJA," *Jurnal Teknik Informatika dan Sistem Informasi*, vol. 8, no. 3, pp. 999-1011, September 2021.
- [15] Dwi, Ardian Praba, "Implementasi Model View Controller Dengan framework CodeIgniter Pada Perpustakaan," *IJSE - Indonesian Journal on Software Engineering*, vol. 4, no. 1, pp. 93-97, Juni 2018.
- [16] Arif Fadlullah, Mulyadi, Rochaniati, and Muhammad, Farhan Nabil, "Pengembangan Sistem Informasi Manajemen Kearsipan Surat Menyurat Berbasis Framework Codeigniter Untuk KPH-KTT," *Jurnal Teknik Informatika dan Sistem Informasi*, vol. 9, no. 2, pp. 1121-1136, Juni 2022.
- [17] "Perancangan Aplikasi Arsip Surat Berbasis Web di Dinas Komunikasi dan Informatika Kabupaten Mandailing Natal," *Competitive*, vol. 17, no. 1, pp. 28-35, Juni 2022.
- [18] Tamando, Hengki Sihotang, "Sistem Informasi Pengagendaan Surat Berbasis Web Pada Pengadilan Tinggi Medan," *Journal Of Informatic Pelita Nusantara (JIPN)*, vol. 3, no. 1, pp. 6-9, Maret 2018.
- [19] Ade Suryadi and Yuli, Siti Zulaikhah, "Rancang Bangun Sistem Pengelolaan Arsip Surat Berbasis Web Menggunakan Metode Waterfall," *Jurnal Khatulistiwa Informatika*, vol. 7, no. 1, pp. 13-21, Juni 2019.



- [20] Sofiansyah Fadli and Khairul Imtihan, "Analisis Dan Perancangan Sistem Administrasi Dan Transaksi Berbasis Client Server," *JIRE (Jurnal Informatika dan Rekayasa Elektronik)*, vol. 1, no. 2, pp. 7-14, November 2018.
- [21] "Pengembangan Model Knowledge Management Menggunakan Pendekatan PIECES Pada Dinas Kominfo Kota Tangerang," *Journal Sensi: Strategic of Education in Information System*, vol. 7, no. 2, pp. 166-175, Agustus 2021.
- [22] Sofiansyah Fadli and Sunardi, "Perancangan Sistem Dengan Metode Waterfall Pada Apotek Xyz," *Jurnal MISI (Manajemen Informatika Dan Sistem Informasi)*, vol. 1, no. 2, pp. 29-35, Agustus 2018.
- [23] Ainiyatul Maghfiroh, Henderi, and Giandari Maulani, "Rancangan Sistem Informasi Pendaftaran Siswa Baru Berbasis Web pada SMK Putra Rifara," *Jurnal Ilmiah MATRIK*, vol. 22, no. 1, pp. 1-7, April 2020.



An Augmented Reality Virtual Guide Museum Multatuli Rangkasbitung Based on Android

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Abstract— Multatuli Museum has been established for several years and is visited by many tourists. However, in practice the Multatuli Museum often lacks museum guides when there is an increase in visits, so that visitors who are not accompanied by a tour guide do not get complete information. In addition, the lack of interest of the younger generation in visiting museum attractions so that by applying Augmented Reality technology to the Multatuli Museum is expected to attract visitors, especially the younger generation. Augmented Reality (AR) is a technology that is able to insert 3D and 2D objects into a real environment in real-time to display a Virtual Guide at the Multatuli Museum. The author creates an animation in the form of a virtual guide for the Multatuli Museum using Blender software to create 3D animations and using Unity software to build the application as well as the Vuforia extension for Unity with C# programming language. The author uses the prototyping method as the application development method and uses the Unified Modeling Language (UML) as the system design. This research produces an Augmented Reality Application that can be used on Android smartphones. This application is capable of displaying 3D animations that provide information about the showrooms in the Multatuli Museum. Based on black box testing all features in the application are 100% running well. with this application visitors feel helped when the tour guide is limited and feel happy because there is still a Virtual tour guide who helps in the museum.

Keywords – *Augmented Reality, Virtual guide, Multatuli Museum, Android*

I. INTRODUCTION

Technological developments are currently developing in all fields, including tourism, and one of the technologies currently developing is Augmented Reality (AR) Technology which is entering a new phase that allows for increased user experience to the perception of reality. Augmented Reality (AR) is a combination of real and virtual objects in a real environment, running interactively in real time and there is integration between objects in three dimensions, namely virtual objects integrated in the real world.[1][2]Information about objects and the environment around us will be added to the Augmented Reality system, which will then be displayed on the real-world layer in real-time as if the information is real.[3]Then, these virtual objects are projected in real time directly through media in the form of markers or markers directed at the camera.[4]The Multatuli Museum is one of the museums in Rangkasbitung, Lebak Regency, but when visiting the Multatuli Museum visitors have difficulty finding information about the available showrooms because there is no tour guide in the museum, there is only one officer who receives visitors. A Tour Guide is a person who provides explanations and pointers to tourists and other travelers about everything that they want to see, witnessed by the tourists concerned when they visit a particular object, or area.[5]In addition, the lack of interest of the younger generation, especially in Lebak Regency, in visiting the Multatuli museum is one of the factors for the lack of visitors to the Multatuli museum.

Based on the above background, the author develops and implements an Android-based Augmented Reality Virtual Guide Museum Multatuli application. Android is an operating system developed for Linux-based mobile devices.[6]This application is developed uses Blender

software to create 3D animations, Unity software to build its applications and Vuforia Engine extensions the most widely used platform for AR development, with support for phones, tablets and VR glasses with C# programming language.[7]The system development method used is a prototype which is a system development method where the results of system analysis are directly applied to a model without waiting for the entire system to be completed, producing a prototype of the software that is used as an intermediary between developers and users to interact.[8]System design using UML (Unified Modeling Language) is a language based on graphics/images for visualizing, specifying, building, and documenting a software development system based on OO (Object-Oriented).[9]In this study, the authors started the stages of data collection through observation, design, implementation and testing. The test used is Black Box testing is a software testing technique that focuses on the functional specifications of the software.[10]In addition, testing the quality of the system that was built was done by distributing questionnaires to respondents, managers and visitors to the Multatuli museum.

The research used as a reference is research[11]Augmented Reality-Based Learning Application in the Wudhu Guide for Children, this application is able to increase the average value of student learning outcomes. Study[3]Application of Augmented Reality Applications for Android-Based Baby Stimulation Recognition, this research is able to make it easier for parents to stimulate their babies properly. Study[12]Application of Augmented Reality Technology in Android-Based Home Catalog Applications. This study concludes that this application makes it easier for buyers to see a house virtually in the catalog provided before buying a house. Study[1]Augmented Reality Markerless Tour



Guide System Utilizing GPS Based Tracking With Android Platform". This research provides ease of use and can be used anywhere because it is applied in Android smartphones. As well as research[13]Tour Guide Application Using Android-Based Location Based Service (LBS) Method (Case Study in Ende Regency - East Nusa Tenggara). The result of this application is that it can provide directions or routes to tourist sites, hotels, and restaurants in Ende Regency.

Therefore, one way to increase the attraction of young generation visitors to the Multatuli Museum is to combine Augmented Reality technology with objects in the Museum so that the enthusiasm of the younger generation to visit the museum becomes greater.

II. RESEARCH METHODOLOGY

This research on the implementation of the Augmented Reality virtual guide application at the Multatuli Rangkasbitung Museum uses method experiment. This study has the aim of exploring the museum, looking for new ideas about museum guides. The steps of this research are:



Figure 1. Research steps

A. Data collection

Collecting data through interview techniques, namely with the Secretary of the Culture and Tourism Office of Lebak Regency, the Head of the Multatuli Museum and the Guards of the Multatuli Museum as well as several visitors to the Multatuli Museum. Various questions about the history of the Multatuli Museum Exhibition Room with the curator of the museum, to obtain an overview, explanation and explanation to assist in making the output of the Augmented Reality application. And the next technique is field observation by researchers to see directly the activities in the Multatuli Museum by making direct observations on the object being studied. The objects studied are 7 exhibition rooms in the Multatuli Museum, Lebak Regency.

B. Design

At the design stage of this application, the system design uses UML (Unified Modeling Language) in the form of use case diagrams and activity diagrams and the development method uses the prototype method.

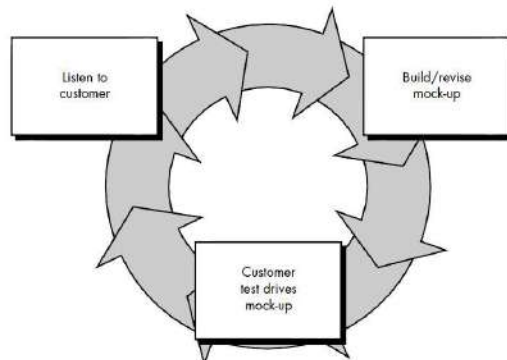


Figure 2. Prototype method.

This application was created using the Blender software to create 3D animations and using the Unity software to build the application as well as the Vuforia extension for Unity with the C# programming language.

C. Implementation

This application is implemented for visitors and managers of the Multatuli Rangkasbitung Museum, Lebak Regency.

D. Test

In this study, the author uses Black Box testing to test the suitability of the input provided with the output generated by the system to IT experts. Black-Box Testing is a test that focuses on the functional specifications of the software, the tester can define a set of input conditions and perform tests on the program's functional specifications.[14]In addition, the authors tested the quality of the system by distributing questionnaires using a Likert Scale to visitors and the manager of the Multatuli Museum.

III. RESULTS AND DISCUSSION

The results of this study include:

A. Data collection

As an illustration of the system currently running at the Multatuli Museum, it can be seen in Figure 3 below:



Figure 3. Overview of the Running System

The flow of a visit to the Multatuli Museum starts with filling out the guest book by visitors, and assisting the museum guide to see the collections in the Museum. When you have finished exploring the museum then visitors leave the location of the Multatuli Museum.

B. Design

At the design stage of this Augmented Reality Virtual Guide application, use case diagrams and activity diagrams are used.

1. Use case Application Diagram

Use case (UC) diagrams, explain visually the context of the interaction between the actor and the system. Each use case states a specification of the behavior (functionality) of the system being described that is needed by the actor to fulfill his goals.[15]The following is the use case diagram of the application:



Figure 4. Use case diagram

In this use case there is only one actor, namely the user who is a passive actor who can only use this application. the user scans using an AR camera to visual objects in the form of image targets that are available in each room. Next the system will process according to the target image that has been planted on the android system, when the system recognizes the appropriate target image, the display on android will display 3D animation objects complete with audio related information about the room the user is going to, including Image Image 1 to 7.

2. Activity Diagrams

Activity Diagrams describes the various flow of activities in a system that is being designed.[16]The following is an Augmented reality application activity diagram.

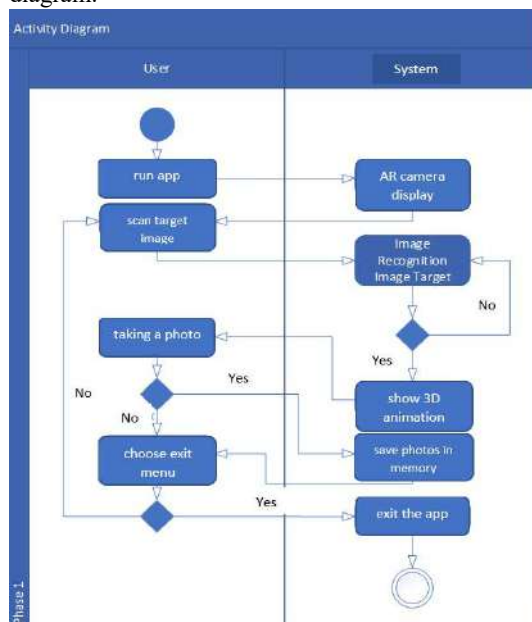


Figure 5. Activity Diagram

users can take photos on the AR camera, so users can take 3d animation and reality photos at the same time.

C. Implementation

This stage is the implementation of the system which is the result of the design in the form of application screenshots.

1. Application Installation

Before operating an application that uses Augmented Reality techniques on the Android platform, it is necessary to make sure we already have an Image (marker) which will be used as an object to be scanned by the AR camera. To operate this application, it can be done directly by opening the application that is already installed on the Android platform.

To install the Augmented Reality Museum Multatuli application on Android devices, you can do 2 ways:

- Building directly through the Unity Application provided that the Android device must be in developer mode and enable usb debugging mode, so that the device can be read by Unity
- Direct application installation that the author has uploaded via:
https://drive.google.com/file/d/10A1ckMwlmmtSoqI62O1VOrI_HB3rO0Vi/view?usp=sharing. Or you can directly scan the QR Code below:



Figure 6. QR Code Application Download AR Virtual Guide Museum Multatuli

2. Application Usage

3D Animation Display is a display that will appear when the user scans a visual object in the form of a predetermined Image in each Showroom using an AR camera. The display of the Multatuli Museum's AR Virtual Guide when finding markers and displaying 3D animation can be seen in Figure 7 below:



Figure 7. Augmented Reality Tour Guide Multatuli Museum

When 3D animation appears on the display, then the information in each room in the museum in the form of audio will be played. Information in the form of audio can be heard clearly, but it is recommended to use a headset so as not to disturb other visitors.

Following are the results of images for each room from rooms 1 to 7 in each museum with different audio information for each room. Image Target is a visual object that is used by AR as a marker when 3D objects are displayed on the display. The image targets used in this study can be seen in the following figure:



Figure 8. Image Room 1

An image in room 1 of the multatuli museum with audio information “Welcome to the Multatuli Museum, Lebak Regency. Introduce my name is Adinda Virtual Guide who will accompany you while exploring the Multatuli Museum. The Multatuli Museum is the first anti-colonialism museum in the world, inaugurated on February 11, 2018 at the former Rangkasbitung Treasury building, on Jalan Alun-Alun Timur Rangkasbitung, Lebak Regency, Banten Province.

The name Multatuli is taken from the pen name of Eduard Douwes Dekker when writing the novel Max Havelaar. This museum has a land area of 1834 square meters and a building area of approximately 314 square meters. With 7 exhibition rooms consisting of the Welcome room, the room for the early arrival of Europeans to the archipelago, the Forced Cultivation Room, the Multatuli room, the Banten room, the Lebak room, and the temporary Museum room.

Currently you are in the Welcome room, in this room there is a statue of Multatuli as well as a mosaic of Multatuli's face and a mockup of the Multatuli museum building which is integrated with the Saija Adinda library"

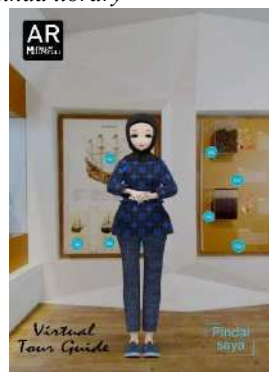


Figure 9. Image Room 2

An image in room 2 of the Multatuli Museum with audio information: “You are in the second room of

the Multatuli museum, which is the first room for Europeans to come to the archipelago. This room displays a 2 minute 40 second documentary which tells about the arrival of the Dutch to Banten, there is also a replica of the ship d'batavia used by Cornelis de Houtman who came to Banten in 1596 and a replica of the ship used by Jacob van Neck in 1598. This room is also equipped with displays of various spices such as pepper, nutmeg, cloves, and cinnamon which were the initial destination of Europeans coming to the archipelago”.



Figure 10. Image Room 3

This is an image in room 3 of the Multatuli Museum with audio information: “You are currently in the third room or the forced cultivation room. You can see a map of forced coffee plantations from 1830 to 1840, in this room also displays a display of the plantation atmosphere at that time. In addition, there is a replica of the coffee pot. During the forced cultivation period, residents were not allowed to drink coffee from the seeds, but from the leaves because the coffee beans had to be handed over to the Dutch colonial government. There are also displays such as a horse saddle which is a means of transportation for plantation supervision on forced cultivation. There was also a government structure during the colonial period in which Multatuli was an assistant resident of Lebak at that time.”



Figure 11. Image Room 4

This is an Image in room 4 of the Multatuli Museum with audio information:” “This is the fourth room or the Multatuli room, in this room you can see Multatuli's masterpiece, the original Max Havelaar book, which is the Masterpiece of this museum, as well as several other works by Multatuli. shown here, there is also an original collection of a tile or

floor of Multatuli's house. This room is equipped with audio and visuals that explain more or less about Multatuli, then there is also Multatuli lithography imported directly from the Netherlands, which is estimated to be in 1864, there is also a replica of the painting of King William III who received a letter from Multatuli on January 18, 1860, where at the end of his letter Multatuli said: "Does Your Majesty know that 30 million people in the East Indies were tortured and oppressed in His Majesty's name?" This room is also equipped with displays of evaluations of Multatuli from people inspired by Multatuli's work, starting from Raden Ajeng Kartini, President Soekarno, Ahmad Subarjo, Pramoedya Ananta Toer, and Mr. Philippines Jose Rizal.



Figure 12. Image Room 5

This is an image in room 5 of the Multatuli Museum with audio information: "Currently you are in the fifth room, namely the Banten room, in this room the rebellion against the invaders, especially those that occurred in Banten until the seconds of independence. These rebellions included the Haji Wakhia rebellion in 1854, there was also a rebellion in Jasinga Bogor in 1825-1830, then there was a rebellion carried out by farmers in Banten led by Haji Wasid in 1888. There is also a history of national movements such as the Sarekat Islam in 1912, Budi Utomo in 1908, Indisch Partij as the first political party in Dutch India which was founded by the triad in 1912. There was also Romusha forced labor during the Japanese colonial period,



Figure 13. Image Room 6

This is an image in room 6 of the multi-tasking museum with audio information: "This is the sixth room or the Lebak room, in this room it tells about

the beginning of the formation of Lebak Regency in 1828. This room also tells the development of Lebak from the leadership of the first Regent, namely RTA. Kartanegara in 1830. With a timeline display or based on the chronology of time to current developments. Not to forget also the remains of artifacts so that Lebak's natural wealth, in this room also exhibited local products, namely Baduy weaving.



Figure 14. Image Room 7

This is an image in room 6 of the Multatuli Museum with audio information: "You are in the 7th room or temporary room and the last one to go to the exit of the Multatuli Museum. Currently there are several Max Havelaar books that can be read by visitors, as well as several profiles of people who have stories in Rangkasbitung. In accordance with the name of the room, this room can change its display layout according to the needs of the museum. Thank you for visiting the Multatuli Museum, Lebak Regency, and maintaining order while you are at the Museum, We look forward to your next visit. Lebak Unique, work with heart.

D. Application Testing

At the stage of testing the system using the Black Box, and also testing the quality of the system by distributing questionnaires to respondents, namely visitors and managers of the multatutu museum.

1. Black Box Testing

Testing is carried out to evaluate the results of the system that has been made. Application testing was carried out on several devices with the Android operating system with 2GB RAM specifications, 16GB ROM, octa core processor @ 1.95 GHz with GPU. This is done to find out the functionality of several different devices. The image that has been prepared for this test is A3 size (29.7 cm x 42.0 cm). This application was tested using 4 different android devices. Installation testing is carried out to ensure the application is installed on the device that is the object of the test

Table 1. Device Installation Test

Indicator	Test	Device	Success	
			Yes	Not
Success in Installation	Was the application successfully installed on the device	Device 1	√	
		Device 2	√	
		Device 3	√	

Device 4 ✓

The loading time response test is carried out to test how long it takes the device to display 3D Animations calculated from the first time the AR camera points to the Image. The following are the results of the loading time response test:

Table 2. Time Loading Response Test Results

Indicator	Test	Device	Length of Time (Second)			
			1	2	3	>3
Response Time Loading	How long does it take for the 3D Animation to appear	Device 1		✓		
		Device 2			✓	
		Device 3	✓			
		Device 4		✓		

Button function testing is done to test whether the exit button and take a photo button work or not. the following are the test results:

Table 3. Test Results for Button Functions

Indicator	Test	Device	Success	
			Yes	Not
Button Function	Does the Exit Button work?	Device 1	✓	
		Device 2	✓	
		Device 3	✓	
		Device 4	✓	

Table 4. Results of Testing the Function of Take Photos and Save Photo Results

Indicator	Test	Device	Success	
			Yes	Not
Button Function	Does the Take photo button work, and the photos are stored in the device memory?	Device 1	✓	
		Device 2	✓	
		Device 3	✓	
		Device 4	✓	

This animation and audio motion test is carried out to test whether the 3D Animation moves and audio is heard. Here are the test results:

Table 5. Test results for animation and audio motion

Indicator	Test	Device	3D Animation Motion	
			Yes	Not
3D Animation Motion	Can 3d animation move well?	Device 1	✓	
		Device 2	✓	
		Device 3	✓	
		Device 4	✓	

Table 6. Audio Test Results

Indicator	Test	Device	Audible Audio	
			Yes	Not
3D Animation Motion	Can the audio be heard well	Device 1	✓	
		Device 2	✓	
		Device 3	✓	
		Device 4	✓	

AR camera testing is carried out to measure the effective distance between the device and the prepared image. Measurements are taken from the minimum distance of the device to display the 3D Animation to the maximum distance of the 3D Animation until it disappears:

Table 7. Results of Testing Effective Distance between Device and Image

Indicator	Test	Device	Effective Distance (Cm)	
			Mini mum	Maxi mum
Effective Distance	How far is the effective distance between Device and Image Target to bring up 3D Animation	Device 1	45	490
		Device 2	55	470
		Device 3	40	500
		Device 4	40	520
		Average	45	495

2. System Quality Testing

This test was carried out by distributing questionnaires to 10 respondents with 9 questions, and 5 value scales ranging from 1 to 5, namely strongly disagree, disagree, undecided, agree and strongly agree, shown in Table 8.

Table 8. Results of the Linkert Skala Scale Assessment

No.	Assessment Aspect	Evaluation				
		SS	S	RG	TS	ST
1	This application can be installed on Android smartphones	10				
2	Button function works fine	9	1			
3	Smooth moving animation	7	2	1		
4	Audio is heard clearly	7	2	1		



5	This application can take and save photos	10		
6	The interface is not confusing	8	2	
7	This application can help visitors understand the contents of each Multatuli Museum showroom	7	2	1
8	The application provides a new experience in visiting museums	9	1	
9	This application is interesting for the younger generation	7	1	2

So it can be concluded according to the results of respondents through the Linkert Scale Assessment that this application is very good in terms of benefits with a result of 93.33%.

IV. CONCLUSION

Based on the results of research conducted regarding the implementation of the Android-based Augmented Reality Virtual Guide Museum Multatuli Rangkasbitung Application, it can be concluded that this study produces a virtual guide for the Multatuli museum with the results of application testing using the black box testing method showing that this application can run well with a distance between 46 - 495 cm with a response time of loading between 1-3 seconds depending on the available ram capacity on the device and this research can attract the interest of the younger generation in visiting the Multatuli museum with the results in terms of benefits of 93.33%.

REFERENCES

- [1] Akbar, A. A. M. (2017). *Sistem Pemandu Wisata Berbasis Augmented Reality Markerless Memanfaatkan GPS Based Tracking Dengan Platform Android (Studi Kasus : Lokasi Wisata di Kota Makassar)*. Universitas Islam Negeri Alauddin Makassar.
- [2] Rawis, Z. C., Tulenan, V., & Sugiarto, B. A. (2018). Penerapan Augmented Reality Berbasis Android Mengenalkan Pakaian Adat Tountemboan. *E-Journal Teknik Informatika Vol.*, 13(1), 30–37. <https://doi.org/10.1080/0163638980190306>
- [3] Yazid, A. R. (2017). *Penerapan Aplikasi Augmented Reality Untuk Pengenalan Stimulasi Bayi Berbasis Android* (Vol. 1, Issue Strata 1). Institut Informatika dan Bisnis Darmajaya.
- [4] Mauludin, R., Sukamto, A. S., & Muhandi, H. (2017). Penerapan Augmented Reality Sebagai Media Pembelajaran Sistem Pencernaan pada Manusia dalam Mata Pelajaran Biologi. *Jurnal Edukasi Dan Penelitian Informatika (JEPIN)*, 3(2), 117. <https://doi.org/10.26418/jp.v3i2.22676>
- [5] Anggraeni, R. (2017). *Perilaku Pemandu Wisata dalam Meningkatkan Kualitas Pelayanan PT. Narasindo Tour and Travel*. Universitas Sumatra Utara.
- [6] Maiyana, E. (2018). Pemanfaatan Android Dalam Perancangan Aplikasi Kumpulan Doa. *Jurnal Sains Dan Informatika*, 4(1), 54–65. <https://doi.org/10.22216/jsi.v4i1.3409>
- [7] Vuforia. (2021). *Vuforia Engine Library 10*.
- [8] Tsani, R. H., & Kurniawan, R. (2021). Perancangan Sistem Informasi Akuntansi Desa Wisata Pentingsari Menggunakan Metode Prototyping. *Automata*, 7.
- [9] Mubarak, A. (2019). Rancang Bangun Aplikasi Web Sekolah Menggunakan Uml (Unified Modeling Language) Dan Bahasa Pemrograman Php (Php Hypertext Preprocessor) Berorientasi Objek. *JIKO (Jurnal Informatika Dan Komputer)*, 2(1), 19–25. <https://doi.org/10.33387/jiko.v2i1.1052>
- [10] Setiawan, D., Fadhillah, M. A., Wibawa, A., Sugiarto, I., Mulyana, A., & Kusyadi, I. (2020). Pengujian Black Box pada Aplikasi Perpustakaan Berbasis Web Menggunakan Teknik Equivalence Partitioning. *Jurnal Teknologi Sistem Informasi Dan Aplikasi*, 3(2), 95. <https://doi.org/10.32493/jtsi.v3i2.3955>
- [11] Jazilah, N. (2016). *Aplikasi Pembelajaran Berbasis Augmented Reality Pada Buku Panduan Wudhu Untuk Anak*. Universitas Islam Negeri Maulana Malik Ibrahim.
- [12] Rizal, M., Afijal, A., & Azmi, D. (2021). Aplikasi Pemandu Wisata Berdasarkan Local Based Service Berbasis Android. *Jurnal Tika*, 6(01), 53–60. <https://doi.org/10.51179/tika.v6i01.414>
- [13] Wolo, Y. E. (2017). *Aplikasi Pemandu Wisata Menggunakan Metode Location Based Service(LBS)*



- Berbasis Android (Studi Kasus Di Kab. Ende-Nusa Tenggara Timur). *Jurnal Mahasiswa Teknik Informatika, 1 No.2(2)*, 24–31.
- [14] Hidayat, T., & Muttaqin, M. (2018). Pengujian Sistem Informasi Pendaftaran dan Pembayaran Wisuda Online menggunakan Black Box Testing dengan Metode Equivalence Partitioning dan Boundary Value Analysis. *Jurnal Teknik Informatika UNIS JUTIS, 6(1)*, 2252–5351.
- [15] Kurniawan, T. A. (2018). Pemodelan Use Case (UML): Evaluasi Terhadap beberapa Kesalahan dalam Praktik. *Jurnal Teknologi Informasi Dan Ilmu Komputer, 5(1)*, 77. <https://doi.org/10.25126/jtiik.201851610>
- [16] Kirana, C., & Wahdaniyah, R. (2018). Implementasi Aplikasi Alumni Berbasis Mobile Application. *Jurnal Edukasi Dan Penelitian Informatika (JEPIN), 4(2)*, 179. <https://doi.org/10.26418/jp.v4i2.25752>

Development of Knowledge Management System to Improve the Performance of the New Student Admission System for Higher Education

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Abstract – The New Student Admission System (PMB) is the main door or core business of the University and requires a good management system. Every Academic Year STMIK Amik Riau forms a committee to carry out this PMB activity. The PBM committee consists of several parts, namely the promotion section, the registration section and the selection section. Each section carries out knowledge sharing or knowledge transfer in carrying out its duties. This knowledge sharing is only limited to informal or formal communication through meetings so that the knowledge sharing process has not been carried out optimally. The purpose of this study was (1) to measure the readiness of human resources in the application of knowledge sharing in terms of the dimensions of knowledge, culture, technology and dimensions and (2) to develop knowledge sharing features in the PMB system to support decision making quickly to increase the business value of the institution. The stages used in this KMS were The 10-Step Knowledge Management Roadmap while the evaluation of the application of KMS used the SECI model. The results obtained in this study are a system that helps new PMB officers learn the STMIK Amik Riau PMB system. so that the new PMB officer does not ask the old officer again.

Keywords – Knowledge Management System, PMB, SECI, STMIK Amik Riau

I. INTRODUCTION

Higher Education is an educational institution that prepares students to become members of society who have both the academic ability and skill [1]. STMIK Amik Riau is one of the universities in Riau province that has a vision to become a superior university in Sumatra by 2030 [2]. In order to be excellent, one of the indicators is the number of students at a college [3]. Various efforts are made by universities to improve services to prospective new students, ranging from promotional activities to New Student Admissions (PMB) activities [4].

The PBM committee consists of several parts, namely the promotion section, the registration section and the selection section, which is the vanguard in conveying the advantages of each study program owned by the college so that prospective students make their choice to register for one of the study programs. The quality of service in the PMB section is one of the determining indicators for prospective students to register themselves as new students in each academic year. Every year the team in charge of PMB activities always changes and there is a change in its duties and authorities. This change causes several problems such as officers having to learn the registration system again, having to be able to be required to understand the previous problems, and so on. Another problem which often arises in terms of communication and coordination is that it takes a long time to communicate and coordinate each section (finance, BAAK, and registration) because each section must check the data held by each section coordinator.

Currently, the STMIK Amik Riau registration website has three functions, namely as Information, PMB Scheduling, PMB Registration, and making PMB reports.

The results from the website which are the data of prospective new students to become students are used by several units. The finance department is still matching the data in the system with the finances provided by the PMB committee in the revenue section that has been inputted into Microsoft excel. Besides, the BAAK department is also still doing manual checking of the data received from finances and systems. Furthermore, in the PDPT section, it checks manually between the system and the registration file. The PMB system is currently well available and can be accessed for transaction activities by prospective students and the PMB committee. This system can be developed by adding a knowledge sharing feature that can minimize coordination and communication problems among departments.

Knowledge Sharing is a reciprocal process by which individuals exchange knowledge (tacit and explicit knowledge) and continuously jointly create new knowledge [5][2]. Every process of sharing knowledge is always related to how to collect and provide information or data to others [6]. Through the exchange of knowledge carried out both formally and, in those interactions, it can share knowledge or information with his fellow colleagues.

Knowledge sharing carried out in PMB activities is currently only informally and formally through meetings and there is no forum to channel knowledge as independent learning and quick decision making. Evaluation of the PMB system is carried out to see the knowledge management system which refers to the Inukshuk method [7]. The Knowledge Management System (KMS) is a tool that aims to support knowledge management, and is the development of an information management tool that integrates various aspects of computer science in supporting collaboration between the work environment and information and



document management systems [8]. The reason why the knowledge management system is analyzed is because KMS has a positive impact on the business continuity of the organization. This happens because KMS is an effective way to translate work experiences on an ongoing basis in the form of knowledge. KMS is also capable of transferring organizational knowledge across time and across space [9].

Research related to KMS has been widely discussed by other researchers, including [10] implementing KMS in the company PT Telekomunikasi Indonesia International to be more efficient in terms of costs, improve the quality of work and make it easier for employees to do work, such as conveying information between employees or employees can exchange information between parts, thus it provides more knowledge for each division, especially division of marketing and sales. Then [11] utilizing the website as a KMS tool is able to create educational innovations for universities. The Most Admired Knowledge Enterprise (MAKE) method was chosen to assess whether AMIK BSI Tangerang is an educational organization that is successful in managing KMS and sharing knowledge between website users, namely students and the academic community.

Based on the results of the analysis, there are a lot of important knowledge whose functions are to support PMB activities. In addition, the purpose of documenting this knowledge is so that the knowledge possessed by each team member does not just disappear and can also be shared with other team members, as well as the creation of a means in discussing and distributing problems and knowledge that is still memorized so that there is no repetition of mistakes that have been made.

II. RESEARCH METHODOLOGY

The stages of research carried out in the study can be shown in Figure 1 below:

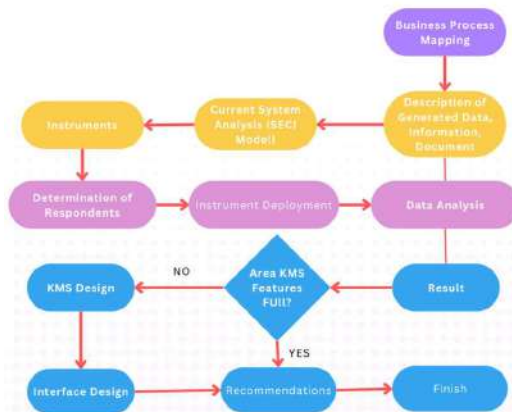


Figure 1. Flow of Research methodology

Based on the stages of research above, each of these stages can be explained as follows:

A. Business Process Mapping

The mapping carried out used the Work System Framework. The Work System Framework in figure 2 is a system where participants consist of humans or machines which carry out business processes using information, technology and other resources to produce a product or

service for internal or external customers.



Figure 2. Work System Framework

The following are the business processes in the admission of new students [12]:

The business process focuses on managing new student admissions starting from meetings or planning for new student admissions, campus promotions, registration fees, entrance tests, graduation announcements to becoming a student. Figure 3 shows the *use case* of the business process of new student admissions (PMB) STMIK Amik Riau. In this study, it was proposed that the Promotion and PMB sections be made into one. This was done so that coordination became easier. Based on previous research, the promotion and PMB sections at the Higher School and University levels were made into one. The results were quite satisfactory in carrying out New Student Admissions and promotion activities. In this proposed system, all reports from each section of the PMB were carried out in an integrated manner.

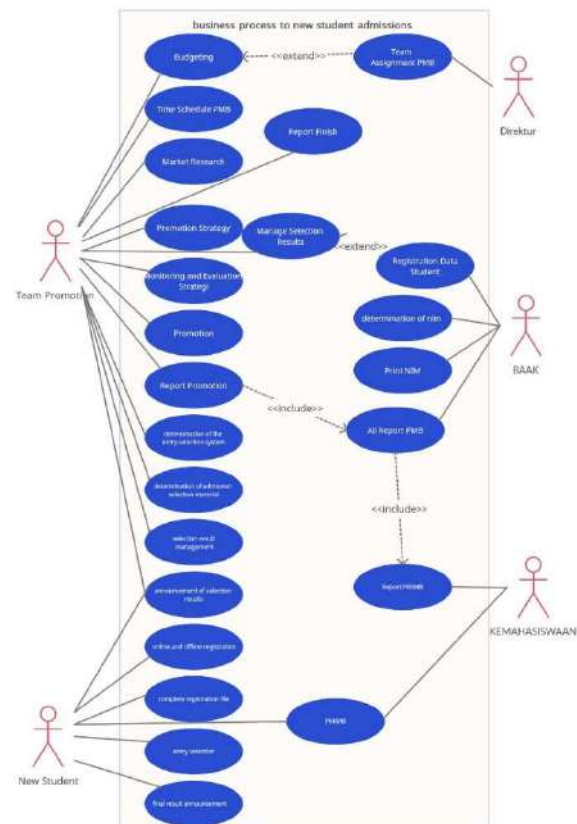


Figure 3. Use case of business process admission of new students



In the figure 3, use case there are 5 user levels, namely the promotion team, new students, Chair, BAAK, and Student Affairs. The levels in the system have different roles. To clarify the *use case* of the new Student Admissions Business process above, details were made to group the existing PMB business process activities and the updates that had been added as presented in table 3.

Table 1. PMB business processes

No	Sub Proses Names	Detail Activities
1.1	new student admission planning	- PMB Team Determination - Budgeting - PMB Time Schedule
1.2	Campus promotion	- Market Research - Promotion Strategy - Oversight and evaluation of strategies - Promotion - Promotional report
1.3	Prospective students' registration	- Registration through online as well as offline - Complete the registration file
1.4	Selection or entrance test	- Establishment of an entrance selection system - Determination of entry selection materials - Entrance selection
1.5	graduation announcement	- Management of selection results - Announcement of selection results - Entry selection report
1.6	becoming a student	- Student registration data collection - Determination of NIM - KTM Printing - Introduction to freshman campus life (PKKMB) - Reporting of freshman admissions

B. System Analysis

Knowledge management system analysis was carried out by using a *secl* model. A knowledge is created through the interaction between tacit and explicit knowledge. SECI has four models of knowledge creation that have been identified. The following is the explanation [13]:

- *Socialization*, the conversion from tacit knowledge into new tacit knowledge, carried out with social interaction and various experiences between members of the organization.
- *Externalization*, the conversion from tacit knowledge into new explicit knowledge.
- *Internalization*, the conversion from explicit knowledge to new tacit knowledge.
- *Combination*, the creation of an explicit knowledge by merging, categorizing, reclassifying, and synthesizing existing explicit knowledge.

The measurement and evaluation of current systems used qualitative methods to develop mathematical models, theories and hypotheses associated with this study. Table 2 presents the instruments used to make measurements of the current system.

Table 2. Research Instruments [14]

Dimensions	Indicators
Knowledge	I understand my task flow well
	I understand the theory relating to the assigned task
	I execute the theory that I got well

	I understand the rules relating to my work
	I have knowledge beyond the assigned tasks
	I always document my knowledge
	The knowledge I have helped me in completing the assigned tasks
Culture	I know the rules where I was assigned
	I have always been disciplined in carrying out my duties
	I made a report according to the specified time
	I always share my knowledge with my colleagues
	I received the information and knowledge that my colleague gave me
	The institution gives awards if my assignment is good
Technology	Teamwork is very helpful in my tasks
	I can use the PMB system well
	So far my understanding of the internet has been good
	I am used to using internet services to support my tasks
	I can upload and download the materials I get on the PMB system
	I always use internet media to share material with my colleagues
SOP	The Internet was very helpful in my task
	The SOP given by the Institution is in accordance with my duties
	The SOP makes my tasks more targeted
	The SOP provided by the institution provides an effective result on my task
	I always communicate the problems I face in the field with my boss
	I have good communication with colleagues and prospective freshmen
	The institution conducts <i>training</i> for assigned staff according to their needs and needs.
	<i>Training</i> provided is in accordance with the material of the institution's SOP

C. Questionnaire Distribution

The distribution of questionnaires on New Student Admissions (PMB) was given to several people in charge of PMB activities. The respondent data was the PBM committee for the 2021-2022 Academic Year. Committee members were lecturers or employees listed in the committee assignment decree issued by the university leadership. Sampling in this study used non-probability sampling which is a sampling technique that does not provide equal opportunities or opportunities for each element or member of the population to be selected into a sample [15]]. Non-probability sampling has several techniques, one of which is saturated samples. The use of sampling was saturated because the population was less than 30 people. Saturated sampling is the number of samples constituting the entire population [16].

D. KMS Model

Building knowledge management was based on the 10-Step Knowledge Management Roadmap which is divided into four phases [17]. These phases are:

- *Infrastructure Evaluation*
- *KM System Analysis, Design and Development,*
- *Deployment*
- *Evaluation*

The KMS model used in this study is shown in figure 4 below:



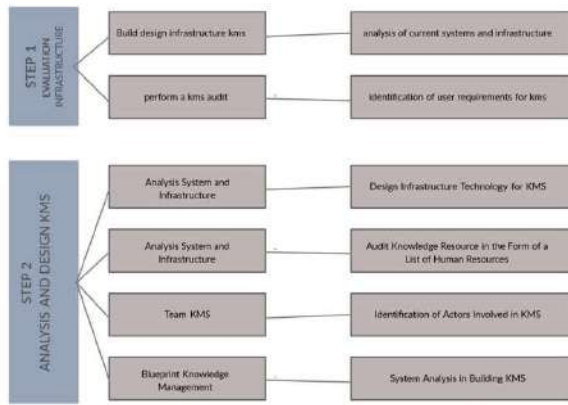


Figure 4. KMS Model

E. Process and Interface Design

Process Design is necessary if the analyzed system requires development or new builds. Process design was used to see the flow of data starting from the input process to the output process. Then designing the interface, the input, and the output utilized UML Tools.

a) Use case

The use case in this study was used to see the relationship between actors and the system used. Figure 5 shows the use case design of the developed PMB system.

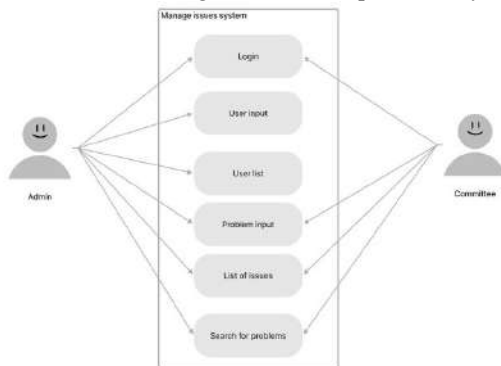


Figure 5. The Use of System Usage

b) User Interface Design

The design of the login page interface consists of two user levels, namely the committee and admin which can be seen in figure 6.

Figure 6. Login Page Design

The design of the user data input interface consisting of username, password, full name, and user level can be viewed in figure 7.

Figure 7. User Data Input Design

Figure 8 shows the interface design of the problem lists inputted by the committee if there are obstacles in carrying out tasks in the admission of new students, both new student admissions officers and interview officers. In this menu, there is also a search menu that is a characteristic of the knowledge management system which is useful for making it easier to find problems.

Figure 8. Design of the List of Issues

Then, figure 9 is the design of problem input consisting of problem and status. Status consists of two options, which are the problem has been handled and has not been handled.

Figure 9. Problem Input Design

F. Recommendations

The evaluation process carried out resulted in the mapping of the Knowledge Management System in the current PMB system. After obtaining mapping from KMS, the next step was to provide recommendations for KMS development in the PMB system by adding a knowledge sharing feature to the PMB system in universities.

III. RESULTS AND DISCUSSION

The followings are the results and discussions carried out in this study.

A. Questionnaire Results



The questionnaire, which was distributed to 17 respondents involved in the admission of new students, received data processed to determine readiness in implementing the new system. The validity results stated that as many as 28 instruments were valid and could be carried out in the next stage. The final result of the respondent analysis found that all respondents were ready to accept the new technology to be applied. The new technology applied is the development of a system, namely by applying a *knowledge management system* to the new student admission system.

B. Implementation of Knowledge Sharing

This section discussed the implementation of knowledge sharing features added to the existing PMB system.

- User Data Input

Figure 10 is a view to add users consisting of two levels, namely administrators and committees.



Figure 10. User Data Input

- User Data

The user data view seen in figure 11 is a list of users who can log in and use the features on this system.



Figure 11. User Data List

- Login Page

The login page in the study will later become a *single sign on* with the parent website of the new student registration of STMIK Amik Riau.



Figure 12. Login Page

- Problem data input

Then after logging in, the committee user level can input data on the problems faced while serving in the admission and interview section. Figure 13 shows the input data of the problem.

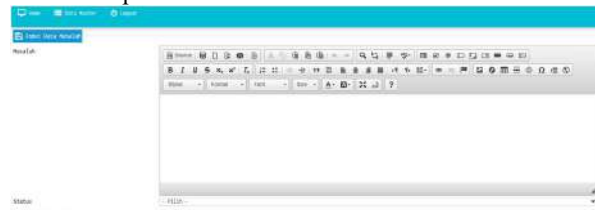


Figure 13. Problem Data Input

- Problem data

Then figure 14 is the data on problems inputted by the committee related to problems that occurred while on duty. In this menu, a problem search feature can also be done to make it easier to find problems. Then the edit sign is used to change the status from unhandled problem to has been handled problem after being solved.



Figure 14. Problem Data

C. Recommendations

The recommendations in this study were used for further development if STMIK Amik Riau develops a new student admission system. The followings were some of the recommendations given by researchers to the development team of the new student admissions system:

- In the newly created system, it is necessary to evaluate so that this system can run according to the desired expectations.
- This system must be integrated with the ongoing new student admission system so that users can more easily perform their duties.
- It is necessary to add a user level to the system such as the promotion section to facilitate coordination between the promotion team and new student admissions officers.

IV. CONCLUSION

The conclusion of this study was that the readiness of users to use KMS on the PMB system has been successfully measured. The presentation value of the measurement results provided recommendations that system users were ready to use the knowledge sharing feature in the PMB system. Then, the development of KMS by adding the Knowledge Sharing Feature to the PMB system had been done well based on the results of trials carried out to input problems that often arise in PMB activities and could be well documented in this system. Furthermore, *knowledge sharing* could be used as a means to exchange information or understanding between individuals, teams, communities or organizations to improve employee and organizational performance. In addition, the addition of the *knowledge sharing* feature had been able to reduce communication barriers among personnel assigned to PMB activities. Then this research is still in the development stage, so it needs to be carried out in the future. Here is the development that is expected for *Knowledge Sharing* feature. It could be used to document knowledge (knowledge, insights, latest trends and self-development tips) in various formats (text, pdf, video, audio, image). Besides, the *Knowledge Sharing* Feature can be developed into a knowledge library which can be accessed by all employees from the internal server (for security) and stores the knowledge library of internal activities.

REFERENCES

- [1] A. Chaerunisyah, "Analisis Pengelolaan Pendidikan Tinggi Swasta Di Indonesia Sebagai Entitas Corporat Non Profit Dan Upayanya Dalam Mempertahankan Eksistensi," *JURNAL ABIWARA*, vol. 3, no. 1, pp. 15–19, 2021, doi: <https://doi.org/10.31334/abiwara.v3i1.1848>.
- [2] T. A. Fitri, M. K. Anam, F. Zoromi, Y. Efendi, and T. Nasution, "Knowledge Management System



- Analysis on The Admission Website for Adding Knowledge Sharing Features,” *CSRID (Computer Science Research and Its Development Journal)*, vol. 14, no. 2, p. 166, Sep. 2022, doi: 10.22303/csrid.14.2.2022.166-175.
- [3] S. Gunawan and P. Palupiningsih, “Pembentukan Model Klasifikasi Data Lama Studi Mahasiswa Stmik Indonesia Menggunakan Decision Tree Dengan Algoritma Nbtrees,” *Kilat*, vol. 6, no. 2, pp. 145–148, 2018, doi: 10.33322/kilat.v6i2.135.
- [4] C. Assimakopoulos, I. Antoniadis, O. G. Kayas, and D. Dvizac, “Effective social media marketing strategy: Facebook as an opportunity for universities,” *International Journal of Retail and Distribution Management*, vol. 45, no. 5, pp. 532–549, 2017, doi: 10.1108/IJRDM-11-2016-0211.
- [5] A. B. Pranogyo, “Penerapan Knowledge Management Untuk Pencapaian Visi Dan Misi Pada PT PERTAMINA,” *Jurnal Akuntansi dan Manajemen*, vol. 13, no. 01, pp. 1–20, 2017, doi: 10.36406/jam.v14i01.183.
- [6] F. Ahmad and M. Karim, “Impacts of knowledge sharing: a review and directions for future research,” *Journal of Workplace Learning*, vol. 31, no. 3, pp. 207–230, 2019, doi: 10.1108/JWL-07-2018-0096.
- [7] O. Octaria, E. Ermatita, and S. Sukemi, “Penerapan Knowledge Management System Menggunakan Algoritma Levenshtein,” *Jurnal RESTI (Rekayasa Sistem dan Teknologi Informasi)*, vol. 3, no. 2, pp. 233–242, 2019, doi: 10.29207/resti.v3i2.1045.
- [8] F. A. Choirunyah and H. Heryanto, “Perancangan Knowledge Management System Pada Tenaga Kependidikan Di Perguruan Tinggi,” *Infomatek*, vol. 21, no. 1, pp. 01–14, 2019, doi: 10.23969/infomatek.v21i1.1609.
- [9] S. Anardani, S. Riyanto, and D. Setiawan, “Perancangan Knowledge Management System Berbasis Web pada Tenaga Kependidikan Fakultas Teknik Universitas PGRI Madiun,” *Jurnal Teknologi Informasi dan Ilmu Komputer*, vol. 8, no. 1, p. 77, 2021, doi: 10.25126/jtiik.0813252.
- [10] D. F. Murad, A. B. Wandanaya, W. J. W. Saputra, and R. Tarmizi, “Knowledge Sharing pada Knowledge Management System PT Telekomunikasi Indonesia Internasional,” *Jurnal Teknik Informatika UNIS*, vol. 6, no. 1, pp. 17–24, 2018, doi: doi.org/10.33592/jutis.Vol6.Iss1.37.
- [11] E. Retnoningsih, “Analisa Penerapan Knowledge Management System Perguruan Tinggi Menggunakan Most Admired Knowledge Enterprise,” *Bianglala Informatika*, vol. 2, no. 2, pp. 1–10, 2014, doi: doi.org/10.31294/bi.v2i2.529.g421.
- [12] M. K. Anam, T. Nasution, S. Erlinda, L. Efrizoni, and Susanti, “The Analysis and Optimization of Business Processes for Students in Higher Education Based on Togaf 9 . 2,” *Scientific Journal of Informatics*, vol. 8, no. 2, pp. 230–243, 2021, doi: 10.15294/sji.v8i1.29952.
- [13] N. Ikujiro and H. Takeuchi, *The Knowledge-creating Company: How Japanese Companies Create the Dynamics of Innovation*. Newyork: Oxford University Press, 1995.
- [14] Maisyaroh, “Pemanfaatan Tools Knowledge Management System Pada Pembelajaran Multimedia Interaktif ‘Virtual Drive Network’ Studi Kasus: Sma Muhammadiyah 13 Jakarta,” *Jurnal Pilar Nusa Mandiri*, vol. XII, no. 1, pp. 21–28, 2016, doi: 10.33480/pilar.v12i1.255.
- [15] H. Siagian and E. Cahyono, “Analisis Website Quality, Trust Dan Loyalty Pelanggan Online Shop,” *Jurnal Manajemen Pemasaran*, vol. 8, 2014, doi: 10.9744/pemasaran.8.2.55-61.
- [16] Y. D. Pertiwi and B. B. Siswoyo, “Pengaruh orientasi pasar terhadap kinerja pemasaran pada umkm kripik buah di kota batu,” in *Seminar Nasional dan The 3rd Call for Syariah Paper*, 2016, pp. 231–238.
- [17] J. S. Suroso, A. S. Girsang, and F. L. Gaol, “Mapping Knowledge management for technology incubation,” *Advances in Intelligent Systems and Computing*, vol. 685, no. March 2019, pp. 179–187, 2018, doi: 10.1007/978-3-319-70019-9_15.

