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Articles

Predictive Analytics for Carbon Dioxide Levels: A Linear Regression Approach

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CO_2 Monitoring System
MQ-135 sensor
Realtime
Linear Regression
IQ Air

ABSTRACT

Air quality in classrooms is very important for health and comfort. Increased concentrations of carbon dioxide (CO_2) due to human activities can cause health problems such as headaches, fatigue and respiratory problems. This research develops an Internet of Things (IoT) based air quality monitoring system using the HC-SR04 sensor to count the number of people and the MQ-135 sensor to measure CO_2 levels. Data is integrated with the Thinger.io platform in realtime and classified based on IQ Air standards. The IQ Air classification consists of : >1600 PPM in the good category, <=2500 PPM in the moderate category, <=3300 PPM in the unhealthy category for sensitive groups, <=4100 PPM in the unhealthy category, <=4900 PPM in the very unhealthy category, and <=5500 PPM in the hazardous category. The LED indicator and buzzer provide visual and audio warnings based on detected CO_2 levels. The linear regression method was used to calibrate the MQ-135 sensor, showing a high level of accuracy with an error percentage of 1.9%. The test results show that this system provides accurate and realtime information to monitor indoor air quality, provides early warning if CO_2 levels reach unhealthy levels, and can improve air quality in classrooms.

INTRODUCTION

Rooms can have various sizes and functions, and they are used for various purposes according to building needs and design (Work, 2024). In a room there is air which is needed by humans and other living creatures to fulfill human needs (Education, 2024). The maximum capacity of a room should not exceed 50% of its maximum capacity, because this can affect air quality (Certified Commercial Property Inspectors Association, 2024). One important parameter that needs to be monitored is carbon dioxide (CO_2) levels (Meter, 2023). The air can be made less fresh and clean by excessive amounts of carbon dioxide (CO_2) (Meter, 2023).

If there are excessive levels of carbon dioxide (CO_2) in the air, it is also air pollution, which can lead to health problems (WHO, 2022). It states that high levels of carbon dioxide are enough to reduce human cognitive abilities, such as the ability to make basic decisions being reduced by around 25% and the ability to think strategically by 50% (Karnauskas et al., 2020). The average concentration of carbon dioxide (CO_2) in the atmosphere remains below 350 parts per million (PPM) (NASA, 2024). The government has set a safe limit for carbon dioxide (CO_2) in Minister of Health Regulation number 1077 concerning Guidelines for Indoor Air Health, namely 1000 PPM in 8 hours (Ministry of Health, 2023). In most cases, the formation of carbon dioxide (CO_2) occurs due to burning of waste and the use of certain tools, such as air conditioners, which pollute the air because they contain dangerous pollutants (Semarang, 2020).

High levels of carbon dioxide (CO_2) in a room can be caused by the large number of people in the room, the wind emitted from the hot AC, and lack of ventilation (Kumar

et al., 2022). Human capacity that exceeds the limits of the room reduces blood flow because the oxygen supply is reduced (Jorner & Casey, 2024). Low blood flow is very dangerous for the brain due to the lack of oxygen being transported through the blood (Harsono, 2020). Carbon dioxide levels that are too high will cause a serious health problem called acidosis (Nandy, 2023).

With current technological developments, monitoring carbon dioxide (CO_2) levels so that they are safe and comfortable can be monitored remotely via Internet of Things (IoT) technology. The Internet of Things (IoT) is used for process automation because it is defined as communication between objects and objects (IBM, 2024). With Internet of Things technology, carbon dioxide in classrooms can be monitored remotely, preventing classroom use that could endanger health. In this research, the process for collecting data was used using the linear regression method. Linear Regression is a statistical method used to create a model that describes how the dependent variable (dependent, response, Y) is related to one or more independent variables (independent, predictor, X) (Wang et al., 2024).

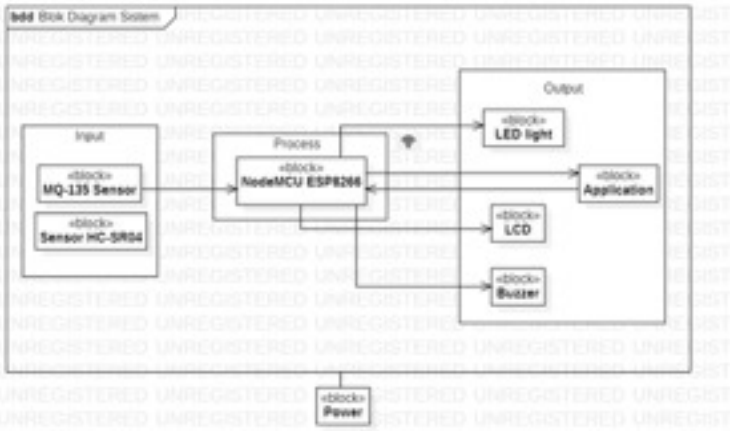

Figure 1. Block Diagram

In Figure 1, the system will use the nodemcu esp8266 as a microcontroller to operate the system. In this research, several inputs were used, such as the MQ-135 sensor for monitoring indoor carbon dioxide (CO_2) levels which produces output in the form of carbon dioxide (CO_2) level values in the form of PPM (Parts Per Million) and the number of people manually. The data read by the sensor is sent to the nodemcu esp8266 microcontroller for processing. Data processed by the microcontroller is forwarded to the system output. The output produced in this research is data obtained by sensors displayed in realtime on the thinger.io website.

RESEARCH METHOD

A method for predicting the value of one variable from another variable. The goal is to estimate the dependent variable (Y) based on the given independent variable (X). The final result of this method is a linear relationship between the independent variable (X) and the dependent variable (Y). Here is the formula:

(1)

In this research, the relationship between CO_2 levels and the number of people present in a room is examined. The CO_2 levels, represented as the dependent variable Y, are influenced by the number of occupants, denoted as the independent variable X. To

understand this relationship, a linear regression model is utilized. In this model, the point where the regression line intersects the Y-axis is known as the intercept, represented by a. This intercept indicates the baseline level of CO_2 when there are no people present in the room. The slope of the regression line, represented by b.
The ratio between the observed value and the predicted value is divided by the observed value and multiplied by 100%. It provides a percentage measure of the relative error between observed and predicted data. The smaller the error percentage, the better the regression model is at predicting the true values. Here is the formula:

(2)

MAPE is used to evaluate the accuracy of prediction models in statistics and machine learning. MAPE provides a measure of the average prediction error as a percentage of the true value, making it easier to interpret how accurate the model is. The lower the MAPE value, the better the model or prediction performance. Here is the formula:

(3)

RESULTS AND DISCUSSION

Data Collection

Data collection was carried out by observation in the Vocational Faculty environment in the K2.04 classroom. The population used in this research was 35 students. The data taken is the number of people in the classroom and carbon dioxide (CO_2) levels. Data for the number of people was taken using the HC-SR04 sensor and data for carbon dioxide (CO_2) levels using the MQ-135 sensor. In table 1, is a data table before the application of the method.

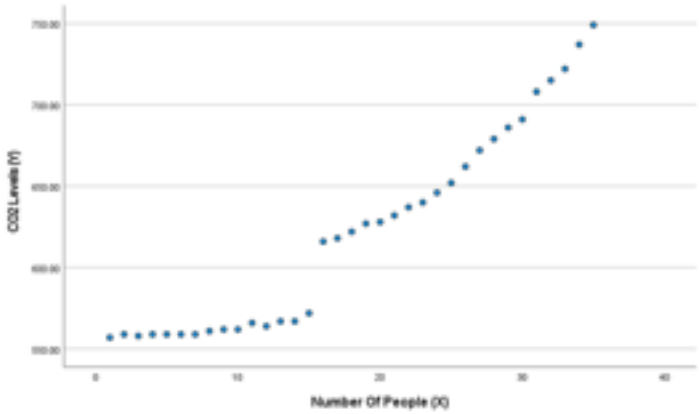

Figure 2. Actual Data Scatter

In Figure 2, shows that in the actual data, there is a very strong positive relationship between the number of people and CO_2 levels, with CO_2 levels increasing as the number of people increases. The high R^2 value (0.9284) shows that this linear regression model is very good at explaining the variability of CO2 levels based on the number of people. This indicates that the measurement of actual CO_2 levels is highly dependent on the number of people. The next process is implementing linear regression to retrieve prediction data by calibrating the sensor. The prediction data obtained will later be used to monitor classroom conditions. With the results a = 5.7692, b = 518.15.

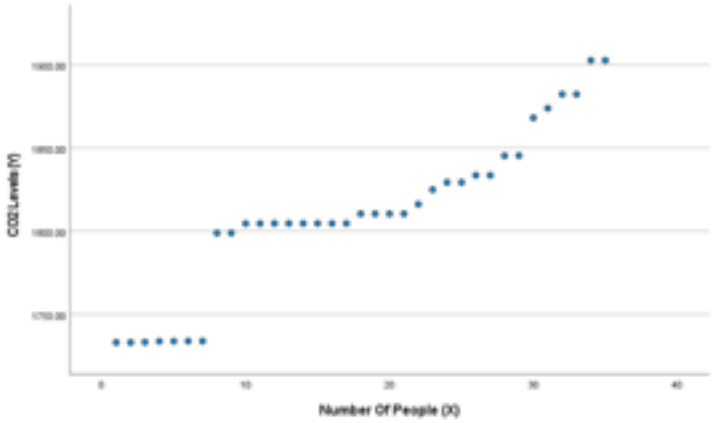

Figure 3. Prediction Data Scatter

In Figure 3, shows that in the predicted data, there is a strong positive relationship between the number of people and CO_2 levels, with CO_2 levels increasing as the number of people increases. The high R^2 value (0.8934) shows that this linear regression model is very good at explaining the variability of CO_2 levels based on the number of people. This indicates that the prediction of CO_2 levels can be highly dependent on the number of people in the model.

Data Analysis

In table 1 is used to provide important information about the independent variables (predictors) being analyzed to determine their effect on the dependent variable (outcome). In table 2 is used to evaluate the performance of the regression model, ensuring that the model is robust and accurately captures the relationship between the dependent and independent variables. In table 3 is used to decompose the variance in the dependent variable into components attributable to the model (regression) and random error (residuals) which can later provide formal statistical test results for the significance of the regression model as a whole. In table 4 is used to interpret the specific contribution of each predictor in the regression model, which allows a detailed understanding of how changes in the predictor affect the dependent variable.

Table 1. SPSS Table

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	Number Of People (X)[b]	.	Enter

a. Dependent Variable: CO2 Levels (Y)

b. All requested variables entered.

Table 2. SPSS Output Table with R^2

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.945[a]	.893	.890	16.18726

a. Predictors: (Constant), Number Of People (X)

Table 3. Analysis of Variance

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	72459.186	1	72459.186	276.533	<.001[b]
	Residual	8646.909	33	262.028		
	Total	81106.094	34			

a. Dependent Variable: CO2 Levels (Y)

b. Predictors: (Constant), Number Of People (X)

Table 4. SPSS Variable Equation

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	1729.822	5.592		309.355	<.001
	Number Of People (X)	4.505	.271	.945	16.629	<.001

a. Dependent Variable: CO2 Levels (Y)

Data Evaluation

Before calculating the average %error, first calculate the %error. After that, calculate the average %error or what is commonly called the Mean Absolute Percentage Error (MAPE)

Which shows that predictions from the linear regression method have a very good level of accuracy. This means that the accuracy level in this system reaches 98.1%.

System Implementation

At the implementation stage the system as a whole is a picture of the system that has been built in accordance with the system design stages. This system was created to be accessed by everyone.

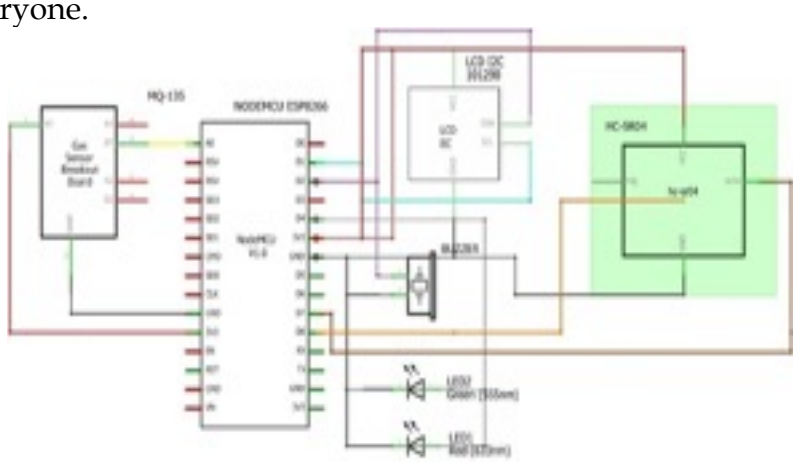

Figure 4. Hardware Schematic Design

In Figure 4, is a prototype of the system. The prototype is designed to meet the requirements required for a carbon dioxide monitoring system. At this stage, an Internet of Things system is implemented consisting of a NodeMCU ESP8266 microcontroller, LED lights, I2C LCD, buzzer, MQ-135 sensor, with operations programmed in C++. In table 5, are the pins of each component attached to the NodeMCU ESP8266.

Table 5. Pin Connection

MQ-135	
Sensor Pin	**NodeMCU ESP8266**
Data (A0)	A0
VCC	3V

.

GND	GND
HC-SR04	
Sensor Pin	**NodeMCU ESP8266**
Trig	D8
Echo	D7
VCC	3V
GND	GND
LED	
Sensor Pin	**NodeMCU ESP8266**
Plus Pole (+)	D4
Minus Pole (-)	GND
Buzzer	
Sensor Pin	**NodeMCU ESP8266**
Plus Pole (+)	D2
Minus Pole (-)	GND
LCD I2C 16x2	
Sensor Pin	**NodeMCU ESP8266**
SDA	D2
SLC	D1
VCC	3V
GND	GND

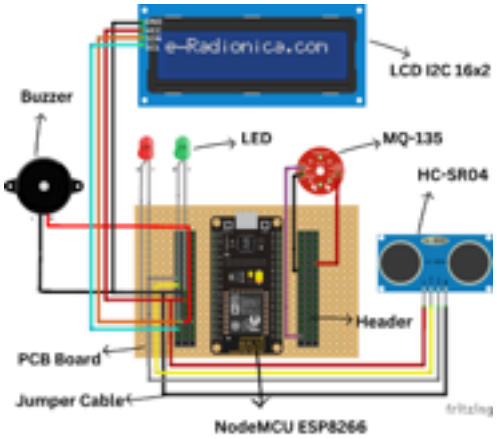

Figure 5. Hardware Design

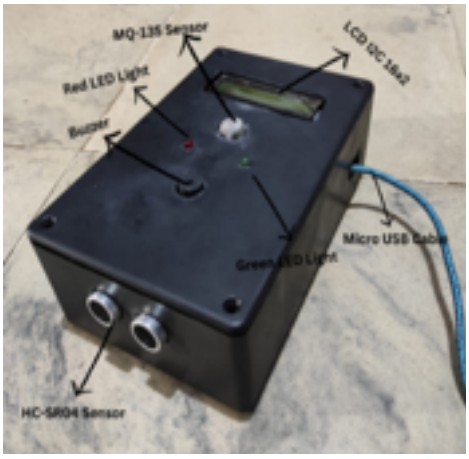

Figure 6. Hardware Packgin Design

In Figure 5, a view of the installed components. In Figure 6, is an image of the hardware packaging where all components have been installed.

Figure 7. Conditions When CO_2 >2500 PPM

Figure 8. Conditions When CO2 <2500 PPM

In Figure 7, when CO_2 > 2500 PPM, the red LED light will light up and the buzzer will turn on. In Figure 8, when CO_2 < 2500 PPM, the green LED light will light up and the buzzer will not sound.

Login Page

Figure 9. Login View

In Figure 9, is something that is done before entering the dashboard of the system, you must log in/create an account first. If you don't have an account then select the create an account menu, if you already have an account then log in directly.

Statistics page

Figure 10. Statistics Display

In Figure 10, after successfully logging in, the initial display of this application is statistics. Statistics is used to provide in-depth insight and analysis regarding device usage and collected data.

Devices Page

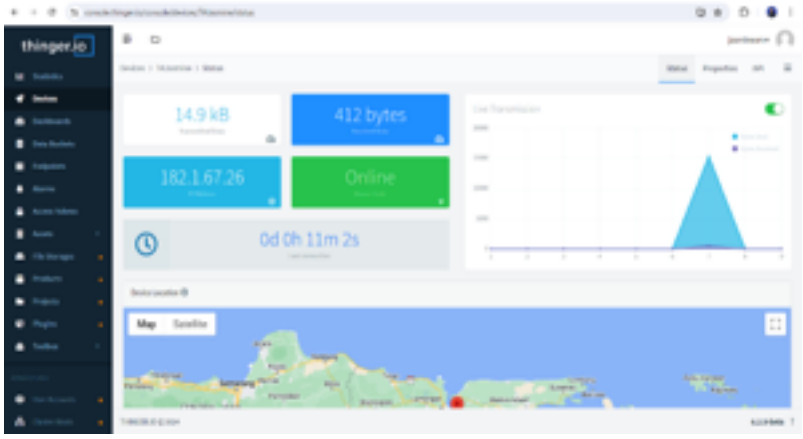

Figure 11. Devices Display

In Figure 11, The devices menu is the management center for devices connected to the platform. Here are some of the main functions and uses of the device menu:

1. Device Management
   a. Addition of new devices.
   b. Device removal.
2. Device Configuration
   a. Device details such as connection status, IP address and last time the device was connected.
   b. Parameter settings such as data capture interval, sensor settings, and network settings.
3. Device Monitoring
   a. Device Connection Status in realtime.

Dashboard Page

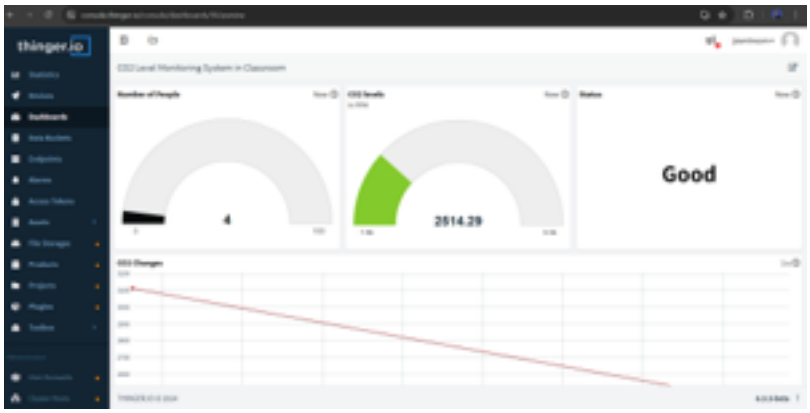

Figure 12. Dashboard View

In Figure 12, the dashboard menu displays features that allow users to create data visualizations and interactive controls for the IoT devices they create. Dashboard is a very useful interface for monitoring and managing data from various devices in realtime.

In this menu you can customize the widget according to your needs. Can display visualization of the data obtained in the form of graphs, charts and gauges. Can control devices with buttons, switches, sliders, and input fields. Can support data integration from various devices and sources, so users can create dashboards that combine data from many sensors or devices. Can set user permissions and share dashboards with teams or the public by setting appropriate access levels.

CONCLUSION

In this research, the HC-SR04 sensor and MQ-135 sensor were successfully integrated into a realtime monitoring system.Implementation of LEDs and buzzers as visual and sound indicators work well. The red LED lights up and the buzzer sounds when CO2 concentrations exceed healthy thresholds, providing a clear warning to users. The implementation of linear regression can provide a percentage error value of 1.9%, which means that predictions from the linear regression method have a very good level of accuracy, namely 98.1%, because the prediction error is relatively small compared to the actual value. The system successfully classifies room conditions based on CO2 concentration. This allows users to know the air quality conditions in realtime and take necessary actions.

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Toward Effective Mental Health Detection: Implementing Forward Chaining Method with DASS-21

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Keywords:
Mental Health
Forward Chaining
Depression
Anxiety
Stress

ABSTRACT

Mental health is an important aspect of quality of life that is often overlooked. This study aims to design a website-based applicationcalled Serenity which is used to detect mental health conditions in the categories of depression, anxiety, and stress. This application utilizes theDepression Anxiety Stress Scale-21 (DASS-21) as a measurement tool and applies the Forward Chaining method to interpret the examination results. In the first stage, a needs analysis is carried out to determine the features to be developed in the application. After that, a system design was carried out that included designing an intuitive and easy-to-use user interface and user experience. The implementation process involves coding using PHP, CSS, Java Script, integration with MySQL databases,and system testing to ensure optimal functionality. The results showed that the Serenity application had an excellent performance with a score of 98% in the PageSpeed Insight test. The system was tested using black box testing which involved users showing results that met expectations and providing accurate results in detecting the user's mental health condition.

INTRODUCTION

Mental health is very important for a person's life, especially in the field of education, especially among students. In order to study smoothly, all students must be in good physical and mental condition (Nurhafiyah & Marcos, 2023). According to the Law of the Republic of Indonesia No. 17 of 2023 concerning health states that health is a condition of a person who is physically, mentally, and socially healthy, not just free from disease that allows him to live productively [2]. In addition, WHO (World Health Organization) also explains that health is a state of complete physical, mental, and social well-being, not just free from disease and weakness (Adam & Marfuah, 2022; Ayuningtyas et al., 2018). When a person can develop physically, mentally, spiritually, and socially so that they have an awareness of their own abilities (the ability to cope with stress, the ability to work productively, and theability to contribute to their community) then, that person can be categorized as mentally healthy (Government of Indonesia, 2014).

Student mental health issues are changing and increasing (Adil & Muzdalifah, 2021). College students are more likely to experience mental emotional health disorders, including depression, anxiety, and other psychiatric problems that have comorbidities (Wahyuni & Winarso, 2022). Because university students are a group of people living in a critical transition period from adolescence to young adulthood (Auerbach et al., 2018). Moreover, compounded by the challenging transition from high school to college, academic pressures, social adaptation, and management of newfound independence. Alarmingly, the WHO reports an increase of more than 25% in common conditions such as depression and anxiety since 2020, affecting nearly one billion people worldwide (Alalalmeh et al., 2024). These mental illnesses affect up to 10% of the global population, and contribute 30% of all non-fatal illnesses worldwide (Ifdil et al., 2020). According to data from the Health Research and Development Agency, in 2006, the number of suicides

in Indonesia each year reached 1800 people. According to this data, 47.7% of suicide victims were aged10-39 years old (Mayatopani et al., 2022).

In addition, the results of the 2018 Basic Health Research published by the Ministry of Health of the Republic of Indonesia 6.1% of people aged 15 years and over suffer from mental disorders with symptoms of depressionand 9.8% suffer from mental emotional disorders. Meanwhile, 6.2% of people suffering from depression and 10% of people suffering from mental emotional disorders are aged between 15-24 years old (Adam & Marfuah, 2022; Adil & Muzdalifah, 2021; Health Research and Development Agency, 2019; Wahyuni & Winarso, 2022). From the news circulating, mental health problems can cause quite dangerous impacts, one of which is death. For example, in the suicide case of one UMY student who committed the action by drinking 20 grains of headache medicine at once on October 1, 2023. The cause of suicide is due to mental health problems. In another case, in October 2022 there was also a suicide case committed by a UGM student, namely by jumping fromthe 11th floor at a hotel in Yogyakarta. The local police revealed that the victim committed suicide because he had a psychological disorder (Chairunnisa & Dwi, 2023).

By looking at the impact and magnitude of the risk caused by mental health disorders, the effort to recognize mental health disorders is to conduct early detection so that treatment is carried out in the early phase. Early detection is done by filling out the Depression Anxiety Stress Scale-21 (DASS)-21 questionnaire for analysis. DASS-21 is used to assess a person's negative emotional symptoms designed to measure the presenceand severity of symptoms of depression, anxiety, and stress (Ifdil et al., 2020). From these symptoms, it will produce five classifications namely, normal, mild, moderate, severe and very severe as a result of early detection (Alalalmeh et al., 2024; Priya et al., 2020; Wahyuni & Winarso, 2022). The advantages of DASS-21 are that it is valid and reliable for measuring depression, anxiety, and stress in college students (Arjanto, 2022). Therefore, DASS-21 is suitable for use in research contexts and clinical applications, including in technology-based mental health detection systems (Ifdil et al., 2020). Meanwhile, the Forward Chaining method is one of the inference methods in rule-based systems. This method works by starting from existing facts and then using rules to get a conclusion or final result (Rizkiah et al., 2020). One of the advantages of the Forward Chaining method is that it is ableto determine the diagnosis results using the available information and perform inference based on predetermined rules (Fatih Sudirja et al., 2023).

Based on this background, this research aims to develop a mental health detection system using the Forward Chaining method which involves the use of the Depression Anxiety Stress Scale-21. It is hoped that this system can help detect mental health problems early on, enable interventions to be made, and increase awareness of the importance of mental health early on. In addition, this research can be used as a model for building similar systems in other educational institutions.

RESEARCH METHOD

The research flow depicted in figure 1 below is to provide an overview of the stages or sequence carried out in the research process to design a website to obtain and collect data with predetermined objectives.

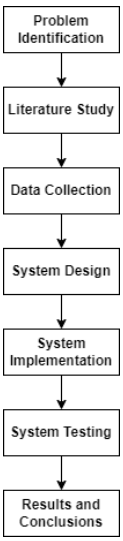


Figure 1. Research Flow

The initial stage that must be done in research is to identify problems regarding the topic taken, namely the lack of student awareness of mental health. So, in this research, a solutionis made in the form of designing an application system that can detect mental health suchas depression, anxiety, and stress.

The measuring instrument used in this study is the Depression Anxiety Stress Scale-21 (DASS-21) which has been translated into more than 40 languages and one of them is Indonesian. In DASS-21 there are 21 questions used to detect depression, anxiety, and stress. This measuring instrument has been tested for reliability with item reliability of 0,99 and person reliability of 0,89 with these values, it can be said that the items used in DASS-21 are valid and reliable (Ifdil et al., 2020). To use DASS-21 in the process of detecting depression, anxiety, and stress, the following knowledge base is used:

1. Detection Question Knowledge Base

Data for this study was collected through the Depression Anxiety Stress Scale-21 (DASS-21) which consists of 21 questions with 7 questions for each of the stress, anxiety, and depression scales. Each question has a different code consisting of S for stress, D for depression, and A for Anxiety as found in table 1.

Table 1. DASS-21 Questions

Code	DASS-21 Questions
S1	Difficult to calm down
A1	Dry mouth
D1	No positive feelings
A2	Difficulty breathing
D2	No initiative in doing things
S2	Overreaction to situations
A3	Trembling

S3	Spending a lot of energy when anxious (nervous)
A4	Worry when panicking
D3	Loss of interest
S4	Restless
S5	Difficult to relax
D4	Sadness and despair
S6	Intolerant of distractions or obstacles
A5	Almost panicked
D5	Pessimist
D6	Life is not valuable and meaningful
S7	Easily offended
A6	Changes in heart rate
A7	Fear for no reason
D7	Life is meaningless (feeling unworthy)

The answer to each question has the following answer score (Priya et al., 2020) as shown in table 2 below:

Table 2. Score Answer

Value	Description
0	Does not apply to me (never)
1	Applied to me to some degree or some of the time (sometimes)
2	Applied to me for most or most of the time (often)
3	Applied to me very much or most of the time (very often)

2. Detection Rule Knowledge Base

The detection rule knowledge base contains rules for tracking mental health detection results in the system. With Forward Chaining, the concept of inference is done using a production rule (IF ... THEN). Detection rules can be seen in table 3 (Wahyuni & Winarso, 2022):

Table 3. Mental Health Detection Rule

Name of Mental Health Disorder	IF-THEN Rule
Stress	IF Difficult to rest (S1) OR Overreaction to things (S2) OR Spends a lot of energy when anxious (S3) OR Restless (S4) OR Difficult to relax (S5) OR Impatient with annoyances or obstacles (S6) OR Irritable (S7) THEN Stress
Depression	IF No positive feelings (D1) OR No initiative in doing things (D2) OR Loss of interest (D3) OR Sad and hopeless (D4) OR Pessimistic (D5) OR Life is not valuable and meaningful (D6) OR Life is meaningless (D7) THEN Depression

Anxiety Disorder	IF Dry mouth (A1) OR Difficulty breathing (A2) OR Trembling (A3) OR Worry during panic (A4) OR Near panic (A5) OR Change in heart rate (A6) OR Fear for no reason (A7) THEN Anxiety Disorder

3. Mental Health Tier Rule Knowledge Base

This knowledge base contains rules to determine the level of a person's mental health disorder. Each mental health disorder has rules in determining the level of mental health. The rules for mental health levels in the stress category can be seen in table 4 (Priya et al., 2020):

Table 4. Stress Levels Rule

Tiers	RULE
Normal	IF sum of weights ≤ 14 THEN Normal
Lightweight	IF sum of weights ≤ 18 THEN Mild Stress
Medium	IF sum of weights ≤ 25 THEN Moderate Stress
Weight	IF sum of weights ≤ 33 THEN Severe Stress
Very Heavy	IF sum of weights ≥ 34 THEN Very Severe Stress

The rules for mental health levels in the depression category can be seen in table 5 (Priya et al., 2020):

Table 5. Depression Levels Rule

Tiers	RULE
Normal	IF sum of weights ≤ 9 THEN Normal
Lightweight	IF sum of weights ≤ 13 THEN Mild Depression
Medium	IF sum of weights ≤ 20 THEN Moderate Depression
Weight	IF sum of weights ≤ 27 THEN Severe Depression
Very Heavy	IF sum of weights ≥ 28 THEN Severe Depression

The rules for mental health levels in the anxiety category can be seen in table 6 (Priya et al., 2020):

Table 6. Anxiety Levels Rule

Tiers	RULE
Normal	IF sum of weights ≤ 7 THEN Normal
Lightweight	IF sum of weights ≤ 9 THEN Mild Anxiety Disorder
Medium	IF sum of weights ≤ 14 THEN Moderate Anxiety Disorder
Weight	IF sum of weights ≤ 19 THEN Severe Anxiety Disorder
Very Heavy	IF sum of weights ≥ 20 THEN Severe Anxiety Disorder

RESULTS AND DISCUSSION

System implementation is carried out to define the results of system design that has been made into a web-based application using the Forward Chaining and DASS-21 methods. This system design uses HTML, CSS, and PHP programming languages. In addition, the necessary data will be stored and managed through the MySQL database. This system is designed to assist users in detecting mental health based on symptoms of stress, anxiety, and depression. Thus, the development of this system aims to provide an effective solutionin helping users to get the right treatment.

Result

The application of the Forward Chaining method in the Serenity application is used for theprocess of interpreting the examination results to produce five classifications for each disorder (depression, anxiety, stress), namely normal, mild, moderate, severe, very severe. The Forward Chaining method is used in the process of matching the facts and data obtained with the rules and knowledge base. The stages of the Forward Chaining method to interpret the examination results are as follows:

1. Completing the DASS-21 Questionnaire which has been adapted into a web-based application through Serenity. Filling out the questionnaire by filling in 7 questions on each disorder (depression, anxiety, stress) as shown in Figure 2.

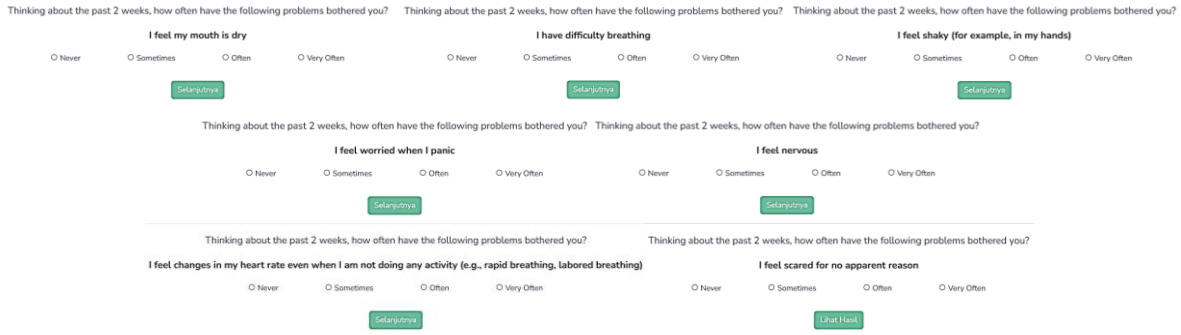


Figure 2. Questionnaire Filling

2. Calculate the score or value by adding up the values which are then multiplied by 2 in each category with the following formula:

$$\text{Stress} = (S1 + S2 + S3 + S4 + S5 + S6 + S7) \times 2 \quad (1)$$

$$\text{Depression} = (D1 + D2 + D3 + D4 + D5 + D6 + D7) \times 2 \quad (2)$$

$$\text{Anxiety} = (A1 + A2 + A3 + A4 + A5 + A6 + A7) \times 2 \quad (3)$$

The calculation of each category in the application is displayed as shown in Figure 3.

A1	I feel my mouth is dry	0	1	2	3
A2	I have difficulty breathing	0	1	2	3
A3	I feel shaky (for example, in my hands)	0	1	2	3
A4	I feel worried when I panic	0	1	2	3
A5	I feel nervous	0	1	2	3
A6	I feel changes in my heart rate even when I am not doing any activity (e.g., rapid breathing, labored breathing)	0	1	2	3
A7	I feel scared for no apparent reason	0	1	2	3

Figure 3. Category Calculation

3. Interpret the results of summing the values which are then multiplied by 2 in each category with the rules and knowledge base of the Forward Chaining method. The application of the Forward Chaining method by matching the results of each category will produce inspection results as shown in Figure 4.

No.	Results	Test Time	Action
1	Severe Anxiety	25 July 2024 10:47:03	Detail
2	Very Severe Anxiety	22 July 2024 12:17:36	Detail
3	Normal Depression	22 July 2024 12:01:40	Detail
4	Mild Depression	21 July 2024 16:19:50	Detail
5	Normal Stress	08 July 2024 18:24:33	Detail
6	Normal Stress	04 July 2024 17:42:52	Detail
7	Very Severe Anxiety	04 July 2024 17:42:10	Detail
8	Moderate Depression	04 July 2024 17:39:43	Detail

Figure 4. Interpretation of Examination Results

In Figure 4, the calculation results in each category will produce examination results in the form of normal, mild, moderate, severe, very severe in each depression/anxiety/stress disorder.

Performance Testing

Performance testing is done using PageSpeed Insight. The results of the Serenity applicationperformance testing are as follows:

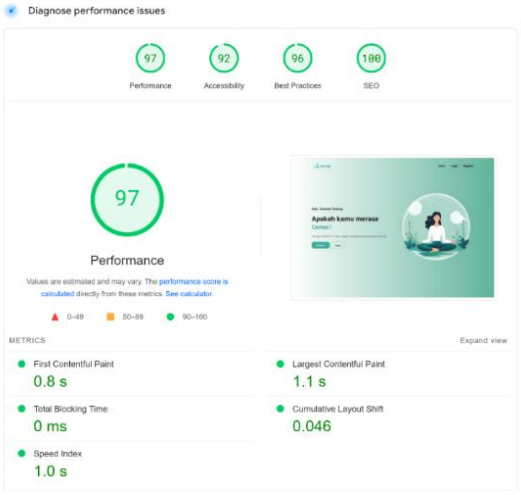


Figure 5. Performance Test

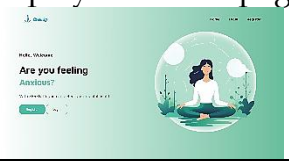
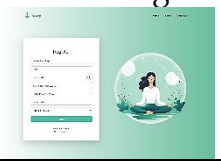
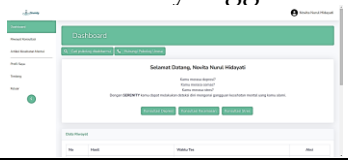
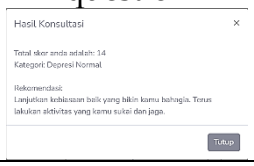
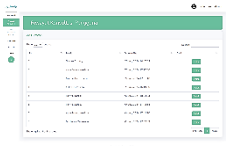
In figure 5, the performance test results of the Serenity application is 98%. These results are good and it can be said that the Serenity application already has almost perfect performance.

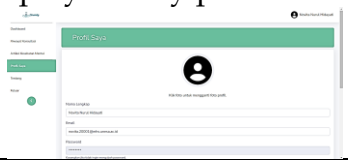
System Testing

The system testing process for the Serenity mental health detection application by implementing the Forward Chaining method with the interpretation of results using the Depression Anxiety Stress Scale–21 (DASS–21), using black box testing, this test is a system testing process to ensure that the output produced is appropriate. This system test is carriedout first independently by trying all the features contained on the website as a whole. Afterthat, direct testing was carried out by involving students of the Faculty of Vocational Studies, Surabaya State University and an expert/expert from the Psychology

S1 lecturer at Surabaya State University. This testing allows the identification and resolution of problems before full implementation of the system, thus ensuring a smooth and efficient user experience. The results of system testing can be defined as in table 7.

Table 7. System Testing

No.	Activities Testing	Expected Results	Results
1.	Open Serenity website	Display the home page 	Valid
2.	Registering an account	Display the account registration menu 	Valid
3.	Doing Log in	Display the login menu  then display the dashboard menu if successfully logged in 	Valid
4.	Mental health consultation	Display questions about mental health  then display the results after answering all question 	Valid
5.	View the results of mental health consultation history	Display the consultation history menu and can also find out the details 	Valid
6.	View the mental health article menu	Display the mental health article menu and then the users can also read the articles	Valid

			
7.	Make changes to profile data	Display the my profile menu 	Valid
8.	Doing Log out	Display the log out confirmation tab  then return to the home page if agree to log out 	Valid

CONCLUSION

Based on the research, it can be concluded that a website application called "Serenity" was successfully developed to detect symptoms of depression, anxiety, and stress early using the Forward Chaining method and the effective DASS-21 measuring instrument. This application has an intuitive display and features such as filling out questionnaires, calculating scores, and classifying results. The performance test showed a success rate of 98%, which means that this application is almost perfect in detecting mental health conditions and is ready for widespread use. System testing is done with black box testing to ensure the output matches the input given, starting with basic functionality testing and continuing with further testing to ensure the application works well under various conditions.

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Integration of Autoregressive Distributed Lag (ARDL) Modeling with Google Search Console Data Analysis for SEO Performance Evaluation

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Search Engine Optimization
Google Search Console
Autoregressive Distributed Lag
Web-based Application
CTR

ABSTRACT

The author designed a website that can be used to analyze Google Search Console performance results with Python and Django implementations to take the Autoregressive Distributed Lag method calculation function with the aim of drawing conclusions about the significance between variables in the long term. Web users will be asked to fill out a form to upload Google Search Console data to be analyzed in CSV format. Then the system will perform three stages of testing, namely stationary tests, optimum lag tests, and regression tests. After all tests are done, the system will display the test results on the same page. The result of this analysis is that the website can analyze Google Search Console datasets that can be uploaded via the CSV document form and will be saved by the system to the database. The conclusion is in long-term relationship of the Clicks variable is valid and variable Impressions, Ranking, CTR, have a positive and significant effect on increasing the number of Clicks. And the results of regression testing with variable dependent CTR is valid. It shows the const and Clicks variable in the long run have a positive and significant effect on the average increase in CTR.

INTRODUCTION

In the last decade, there has been a significant evolution of marketing to become more digitalized with the presence of online platforms and digital marketing technologies. Of all the modern marketing techniques and tools, digital marketing resources, channels, and social media are the most interactive, engaging, and important [3]. Digital promotion is a very innovative and new idea in the 21st century. Although marketing products or assistance via the internet is very efficient but expensive than traditional product marketing [8]. Digital marketing is the latest and most effective way to market products in the digital era. With the potential to gain buyer reach and increase brand awareness which aims to increase product sales, this is the reason why business people should consider digital marketing strategies in their sales. Search Engine Optimization (SEO) is one of the digital marketing strategies that utilizes the Google search engine algorithm because in several website page views, sellers can already provide various product information needed by buyers. Google also plays an important role in sorting the information displayed on buyer searches based on the ranking of the most relevant websites with search keywords, search locations, and interesting content [9].

This study will provide an overview of how digital promotion will be more efficient with some data presented through Google Search Console, such as the number of website visitors calculated through clicks and impressions, the average Click Through Rate generated by website visitors, and the average website search ranking after being indexed by the Google search engine. The application of the Search Engine Optimization concept will be able to help develop the MSME market by increasing the visibility of swallow bird sound products to potential customers throughout Indonesia [1]. Google Search Console

analyzed data to map the company's digital marketing strategy that is being and will be implemented [6]. The method used in this study is the Marketing Funnel, a marketing concept that explains the customer experience before getting to know the product, getting to know it, making decisions, to making purchases and evaluating the company's products. The purpose of this study is to measure the effectiveness of digital marketing owned by the Graha Office company in the period August-December 2023.

With increasing awareness of the benefits of modern digital marketing, business actors are required to understand the correlation of digital marketing strategies applied to micro business products with the visibility of their websites on search engines [7]. However, in reality, many MSME business actors are not yet aware of the benefits of digital technology for their business. Lack of understanding of the benefits and how to do business on the internet is an obstacle that will be faced during the research. MSME business people need to develop their business to be able to survive in this digital industry by applying the concept of digital marketing, especially SEO, to their product websites. Through this research, we design a website that can analyze business web performance and provide conclusions on short-term & long-term strategies that must be used to improve business web performance in order to gain wider customer reach. By having a website that reaches a wide traffic area, it will have high potential to become a good business [4], so that it can expand the market reach so that the scope of potential customers will also be greater.

Search Engine Optimization is an important concept in digital marketing because of its ability to increase website visibility in the Search Engine Result Page (SERP). A search engine is an application programmed to help search for information on the internet by entering search keywords. Search engines are usually accessed through pages on websites that allow users to search billions of website content [10]. According to Janner Simarmata, keywords will be matched by the search engine with its database [11]. Researchers who study SEO have various points of view and opinions in defining SEO itself, citing in their journal who argue that SEO is "a science applied by webmasters, web developers, and website content writers to get top ranking on search engine pages." [2]. They also argue that the high percentage of internet traffic that is done through search engines is directly proportional to the importance of a website's ranking on search pages. Google Search Console is a free service from Google that has tools and analytics to improve website optimization on the Google search engine. GSC provides insight into how a website's performance interacts with Google search. Google Search Console can facilitate the work of web developers by analyzing errors, providing website performance data, and correcting SEO weaknesses on the website to be developed for the better. Google Search Console can also sort out which pages to display or hide from Google search pages, this will be useful if there is information about the website that web visitors do not need to know or if you want to form a certain branding for the product being sold.

RESEARCH METHOD

The method section of this report will provide a comprehensive overview of the research design, detailing the systematic approach and procedures employed to conduct the study. It will outline the data collection methods, specifying the tools and techniques used to gather relevant information, including surveys, interviews, and observational

strategies. Additionally, the section will explain the data analysis process, describing how the collected data was processed, interpreted, and evaluated using various analytical techniques and statistical tools. This thorough explanation will ensure clarity and transparency in understanding the methodologies utilized, enabling replication and validation of the research findings.

This research uses a quantitative approach. Meaning, this is approach used in a study that uses data in the form of numbers and an analysis process using statistical tools [13]. This study uses a graphical approach and statistical tests, where as much as 4 data obtained from the Suarawalet.id website will be analyzed using the Autoregressive Distributed Lag model on the website designed by the researcher to determine the advantages and disadvantages of website performance in the short and long term. The characteristics of quantitative research are systematically arranged, planned, and clearly structured from the data collection stage to data analysis [12]. This research uses time series data. Time series data is data that is chronologically arranged based on time used to see the influence within a certain time span [5]. In this study, researchers took a time limit of 6 months, starting from April 1, 2023 to October 1, 2023. The data variables taken are the number of clicks, the number of impressions, the average percentage of Click Through Rate (CTR), and the average ranking. The variables mentioned on Table 1 are explained operationally with the following definitions.

Table 1. Variable Definitions

Variable	Definition	Long-term Hypotesis (α_x)	Short-term Hypotesis (β_x)
Clicks	The number of user clicks to your site is affected by the type of search results and how they are tabulated	Dependent Variable	Dependent Variable
Impressions	The frequency with which users find links to websites in search results varies, with records for image search and other results determined by the number of impressions on the user's screen.	Positive	Positive
Ranking	A website's average rank in search results is determined by its highest rank each time it appears in SERPs. The rank of each page is detailed in different tables on Google Search Console.	Negative	Negative
CTR	It represents the percentage of impressions that convert into clicks.	Dependent Variable	Dependent Variable
e	Error Term	-	-

From the web-based application that will be developed by researchers, application users can analyze website performance data obtained from Google Search Console by entering the value of each data. There are 3 tests of data analysis that will be carried out by the application to get maximum conclusions and results

Stationarity test will be the first test performed by users in analyzing Google Search Console data. This test will need to be done so that the value of each variable under study is around the average value with fluctuations that are independent of time and variance. In other words, the stationary test will identify influential variables in time series analysis so that the resulting short-term and long-term estimation calculations become consistent and can be interpreted appropriately. In the context of this research, researchers will conduct a stationary test on the number of clicks, number of impressions, average rank, and CTR (Click Through Rate) data. This stationarity test will also use the ADF (Augmented Dickey Fuller) method which is useful for showing whether a variable is stationary or not. The variable will be declared stationary if the ADF probability level of the variable touches the Mackinnan Critical Value (<5%).

After the stationarity test has been carried out, it will proceed to the next test, namely the optimum lag test. This is important to do at an early stage before the calculation is carried out because it will reveal that the optimum lag test is carried out to determine the most optimal lag criteria that will be used for further analysis. The selection of the right lag optimum can produce accurate calculations in the process of long-term identification of each variable. There are several criteria used in determining the optimal lag, namely the Likelihood Ratio (LR), Final Prediction Error (FPE), Akaike Information Criterion (AIC), Schwarz Information Criterion (SC), and Hannan-Quinn Information Criterion (HQ). The way to determine the most optimal lag criteria is by looking at the highest number of stars contained in each of these criteria and the optimum lag will be used in the next test. The Autoregressive Distributed Lag (ARDL) model is the last test in a series of data analysis on Google Search Console. Regression test will be adopted as a data analysis technique in this study to determine the effect of variables in one period by using the optimum lag of the dependent variables (ΔClick & ΔCTR) simultaneously.

$$\boldsymbol{clicks_t = \gamma_1\, impressions_t + \gamma_2\, ranking_t + e} \quad (1)$$

where $clicks_t$ is total clicks variable $impressions_t$ is total impressions variable, and e is error term. Based on equation 1, the ARDL calculation formula equation is as follows.

$$\Delta \boldsymbol{clicks_t} = \sum_{k=1}^{n1} \boldsymbol{\alpha_1 \Delta impressions_{t-1}} + \sum_{k=1}^{n2} \boldsymbol{\alpha_2 \Delta ranking_{t-1}} + \boldsymbol{\beta_1 \Delta impressions_{t-1}} + \boldsymbol{\beta_2 \Delta ranking_{t-1}} + \boldsymbol{e} \quad (2)$$

Δ_t is the first difference of each variable, coefficient $\alpha_1 - \alpha_2$ show the long dynamic relationship between variables, coefficient $\beta_1 - \beta_2$ show the short-term dynamics between variables. From equation 2, the calculation of error connection can be defined as follows

$$\Delta \boldsymbol{clicks_t} = \sum_{k=1}^{n1} \boldsymbol{\alpha_1 \Delta impressions_{t-1}} + \sum_{k=1}^{n2} \boldsymbol{\alpha_2 \Delta ranking_{t-1}} + \boldsymbol{\beta_1 \Delta impressions_{t-1}} + \boldsymbol{\beta_2 \Delta ranking_{t-1}} + \boldsymbol{\delta EC_{t-1}} + \boldsymbol{e} \quad (3)$$

Where EC_{t-1} is defined as error connection and δ can be defined as error connection parameter. Based on the results of long-term regression testing, it is found that the variable C (error term) is negative and insignificant to the number of clicks. While the two variables number of impressions and average rating are positive and significant to the number of clicks. To get accurate and consistent results, this study also uses an approach to the effect of average rank with average CTR.

$$\boldsymbol{CTR_t = \alpha_1\, ranking_t + \beta_1\, ranking_t + e} \quad (4)$$

where CTR_t is the Click Through Rate (CTR) variable, Type equation here. is the ranking variable, and e is the error term. Based on equation 4, the ARDL calculation formula equation is as follows

$$\boldsymbol{\Delta CTR_t = \sum_{k=1}^{n1} \alpha_1 \Delta ranking_{t-k} + \beta_1 \Delta ranking_{t-k} + e} \quad (5)$$

Based on the results of long-term regression testing in equation 5, it is found that the variable C (error term) is positive and significant to the average CTR. While the average rank is positive and significant to the average CTR.

RESULTS AND DISCUSSION

This section presents the research results and findings, showcasing the data collected and analyzed throughout the study. The findings are meticulously displayed using a combination of words, tables, figures, and photographs to ensure clarity and comprehensibility. There are 3 tests of data analysis that will be carried out by the application to get maximum conclusions and results, as if:

In this stationarity test shows the system will take the variables of number of clicks, number of impressions, average rank, and CTR (Click Through Rate) and then the analysis process will be carried out using the ADF (Augmented Dickey Fuller) method which aims to determine the stationarity or not of a variable. The variable will be declared stationary if the ADF probability level of the variable touches the Mackinnan Critical Value (less than 5% or 0.05). The following are the results of the variable stationarity test. It can be seen in Figure 1 that all variables tested have a P-value of less than 5% or 0.05, so all variables can be declared stationary.

Variable	ADF Statistic	p-value
Clicks	-10.838	0.000
Impressions	-4.112	0.006
Ranking	-12.345	0.000
CTR	-6.379	0.000

Figure 1. Stationerity Test

The optimum lag test is conducted to determine the most optimal lag criteria that will be used for further analysis. The selection of the right optimum lag can produce accurate calculations in the long-term identification process for clicks in Figure 2, impressions in

Figure 3, and ranking in Figure 4 to find the most optimal lag calculation for each variable. The results of the most optimal lag will be used as variables in the regression test.

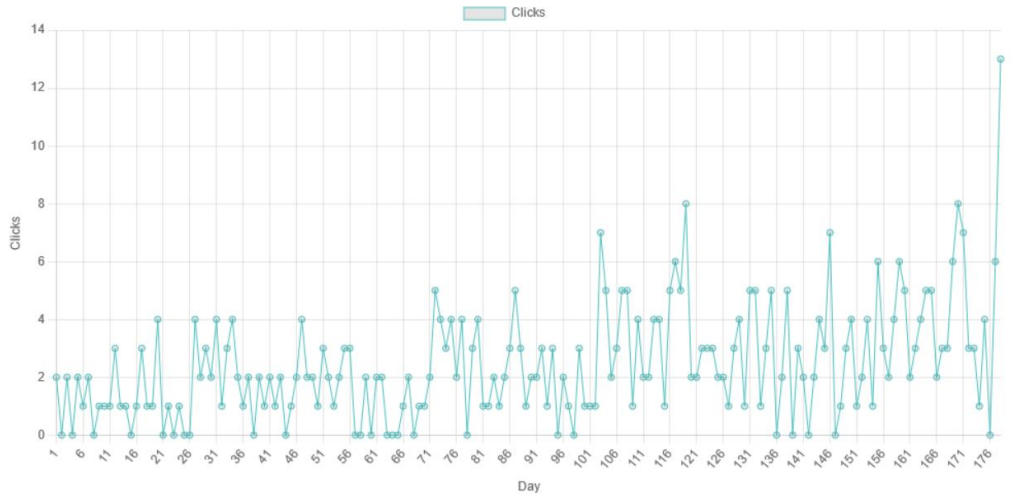

Figure 2. Optimum Lag Test Results for Variable Clicks

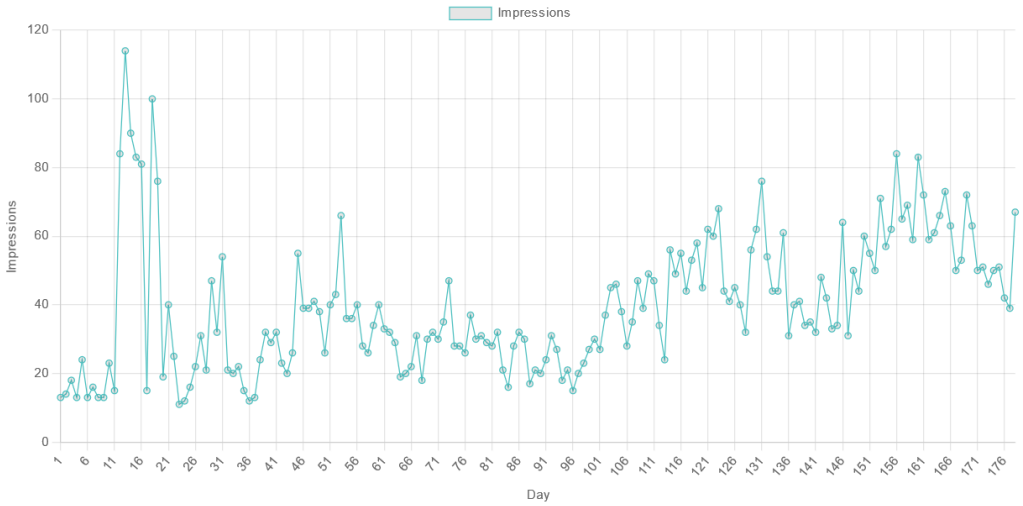

Figure 3. Optimum Lag Test Results for Variable Impressions

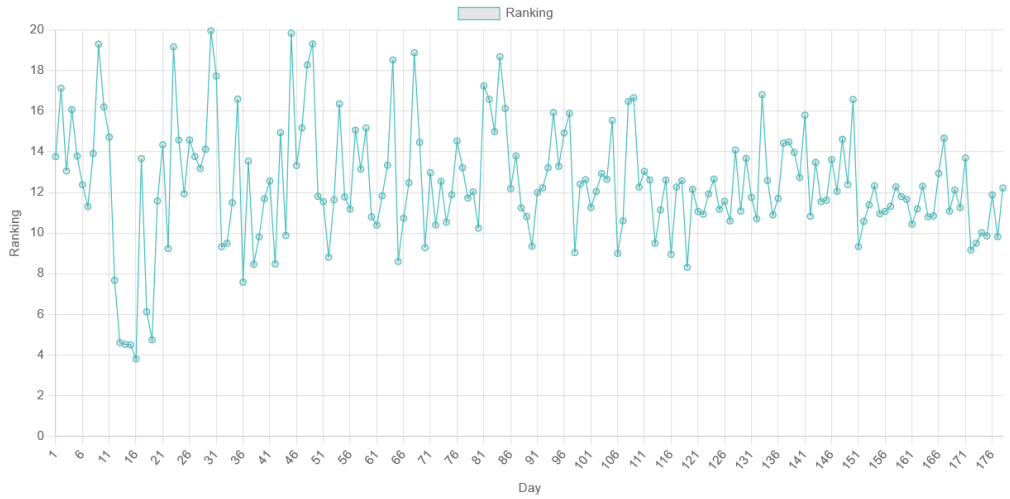

Figure 4. Optimum Lag Test Results for Variable Ranking

Regression tests are useful for seeing the long-term effect of a variable in a certain period of time by using the optimum lag of the dependent variable. A variable is declared to have an influence on the dependent variable if the coefficient value (coef) is positive. Then the significance of a variable on the dependent variable can be seen from the t-statistic (t) which is positive. This is the results from regression test with the dependent variable Clicks according to GSCount. Based on the results of long-term regression test in Figure 5, the coef and t-statistics of the variables C (error term) and Impressions are positive, indicating significance to the dependent variable Clicks. Meanwhile, the coef of Ranking is negative and the t-statistics of Ranking is negative, which means there is no significance to the dependent variable Clicks. To get accurate and consistent results, this research also uses analysis with the average CTR dependent variable.

OLS Regression Results

Dep. Variable:	Clicks	**R-squared:**	0.790
Model:	OLS	**Adj. R-squared:**	0.786
Method:	Least Squares	**F-statistic:**	217.7
Date:	Wed, 10 Jul 2024	**Prob (F-statistic):**	1.18e-58
Time:	08:29:22	**Log-Likelihood:**	-233.62
No. Observations:	178	**AIC:**	475.2
Df Residuals:	174	**BIC:**	488.0
Df Model:	3		
Covariance Type:	nonrobust		

	coef	**std err**	**t**	**P>|t|**	**[0.025**	**0.975]**
const	-3.0157	0.437	-6.907	0.000	-3.878	-2.154
Impressions	0.0562	0.004	14.299	0.000	0.048	0.064
Ranking	0.0834	0.026	3.253	0.001	0.033	0.134
CTR	33.2854	1.428	23.313	0.000	30.467	36.103

Omnibus:	29.193	**Durbin-Watson:**	1.334
Prob(Omnibus):	0.000	**Jarque-Bera (JB):**	183.701
Skew:	0.255	**Prob(JB):**	1.29e-40
Kurtosis:	7.951	**Cond. No.**	960.

Figure 5. Regression Test Results Variable Clicks

Based on the results of long-term regression testing on Figure 6, it is found that the coef variable C (error term) is positive and the t-statistics are also positive, which indicates significance to the CTR average. While the Ranking coef is negative and the Ranking t-statistics are negative, which means that it is not significant to the CTR average dependent variable.

OLS Regression Results

Dep. Variable:	CTR	**R-squared:**	0.766
Model:	OLS	**Adj. R-squared:**	0.762
Method:	Least Squares	**F-statistic:**	189.9
Date:	Wed, 10 Jul 2024	**Prob (F-statistic):**	1.23e-54
Time:	08:29:22	**Log-Likelihood:**	415.02
No. Observations:	178	**AIC:**	-822.0
Df Residuals:	174	**BIC:**	-809.3
Df Model:	3		
Covariance Type:	nonrobust		

	coef	**std err**	**t**	**P>|t|**	**[0.025**	**0.975]**
const	0.0928	0.011	8.588	0.000	0.071	0.114
Clicks	0.0228	0.001	23.313	0.000	0.021	0.025
Impressions	-0.0014	0.000	-12.999	0.000	-0.002	-0.001
Ranking	-0.0022	0.001	-3.224	0.002	-0.003	-0.001

Omnibus:	31.707	**Durbin-Watson:**	1.746
Prob(Omnibus):	0.000	**Jarque-Bera (JB):**	61.278
Skew:	0.847	**Prob(JB):**	4.94e-14
Kurtosis:	5.322	**Cond. No.**	277.

Figure 6. Regression Test Results Variable CTR

In this section, system will define what is the conclusion of all three tests as you can see in Figure 7, Figure 8, and Figure 9 so users can get the digital marketing suggestion on how and what to improve on Google Search Console. Hoping, the micro businesses can easily improve their digital marketing and search engine optimization strategies with the help of GSCount suggestion on test conclusion on Figure 10.

STATIONERITY TEST

In the first test, namely the stationary test, the variable is declared stationary if the P-Value is less than 5% or 0.05.

Conclusions
Clicks is stationary
Impressions is stationary
Ranking is stationary
CTR is stationary

Figure 7. Stationerity Test Conclusion

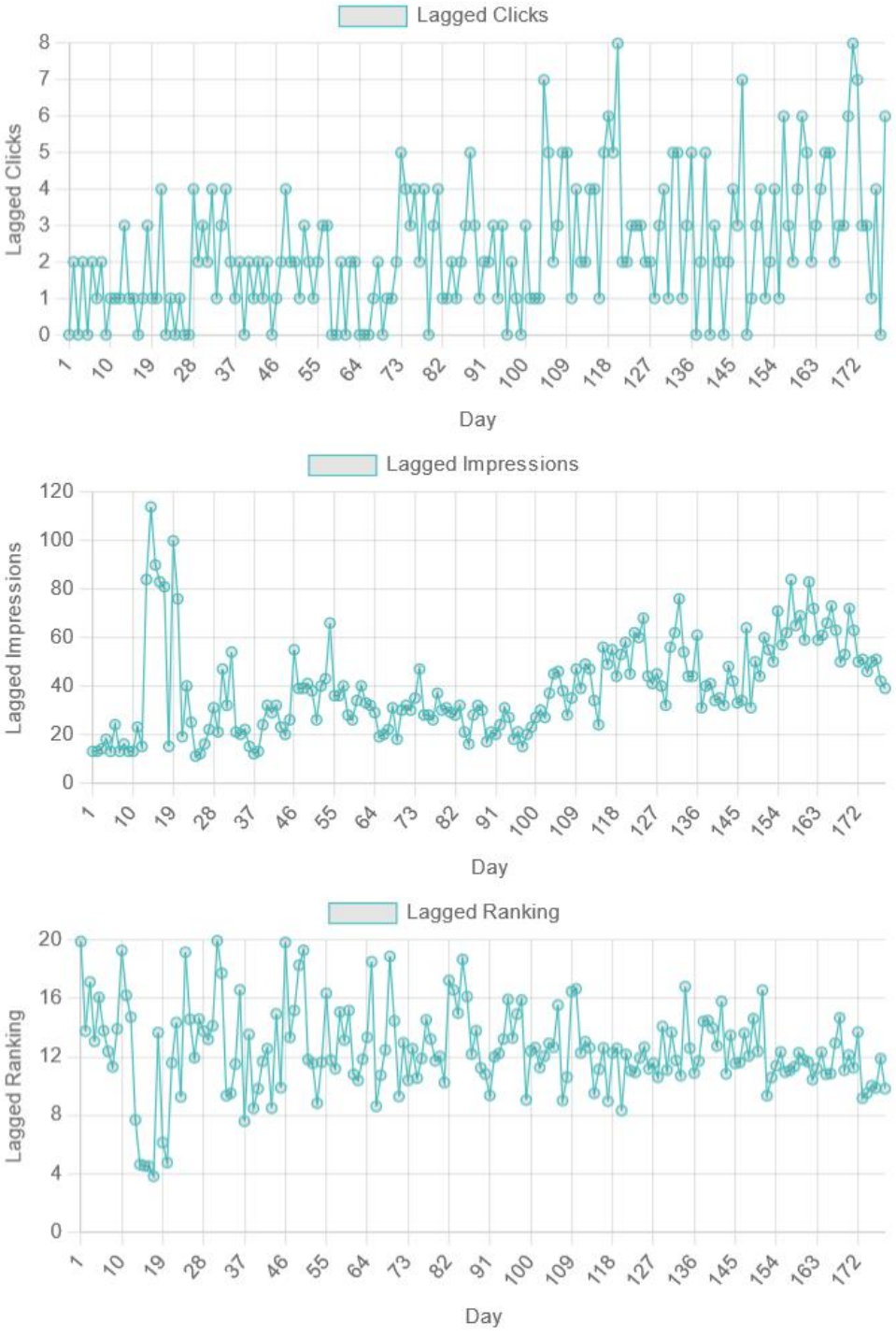

Figure 8. Optimum Lag Test Conclusion

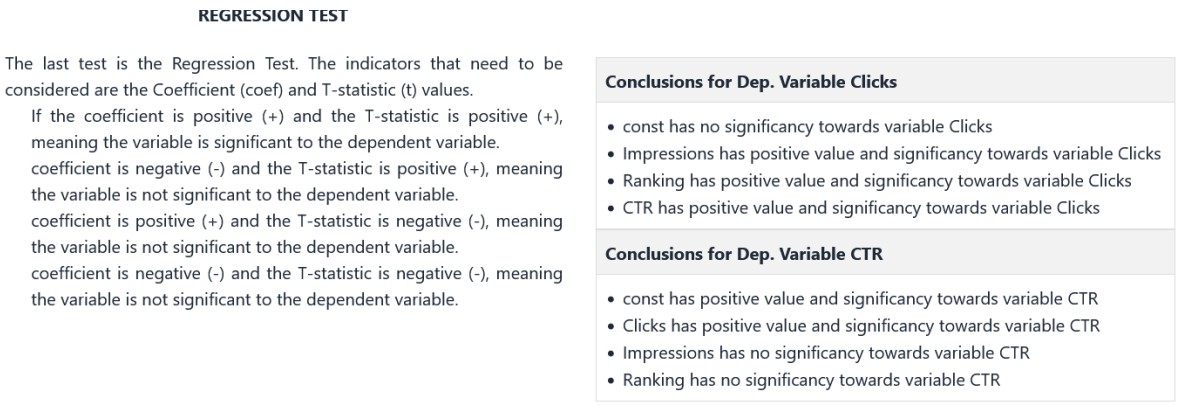

Figure 91. Regression Test Conclusion

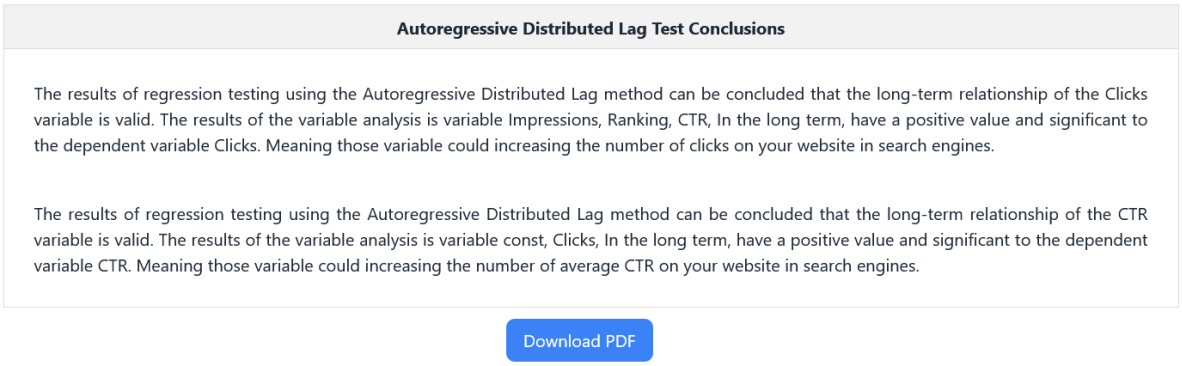

Figure 10. Test Conclusion and Suggestion

CONCLUSION

The conclusion of the Development of Website-Based Google Search Console Data Analysis Application Using Autoregressive Distributed Lag Method is that the GSCount web can analyze Google Search Console datasets that can be uploaded via CSV document form and will be saved by the system to the GSCount database.

The results of regression testing using the Autoregressive Distributed Lag method can be concluded that the long-term relationship of the Clicks variable is valid. The results of the analysis of the variables Impressions, Ranking, CTR, in the long run both on the dependent variable Clicks have a positive and significant effect on increasing the number of clicks on your website in search engines. The results of regression testing using the Autoregressive Distributed Lag method can be concluded that the long-term relationship of the CTR variable is valid. The results of the analysis of the const variable, Clicks, in the long run on the dependent variable CTR have a positive and significant effect on the average increase in CTR. This means that if you intend to increase sales (CTR), then you must increase the number of clicks (Clicks) of visitors. In addition, the analysis results can also be downloaded in pdf format to be accessed without the internet.

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Enhancing Waste Bank Efficiency Through a Web-Based Information System with Haversine Method Route Optimization

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Keywords:
Management Information System, Leaflet JavaScript Library, Haversine Formula, Waste Bank, Waterfall

ABSTRACT

The Government of Mojokerto City is an enclave area within Mojokerto Regency, East Java Province, which has faced challenges in waste management. One effective solution is by utilizing a waste bank system. As a recent innovation, researchers have introduced Waste Bank, a concept of collection boxes for donating clothes and fabric scraps, in collaboration with the Department of Environment of Mojokerto City to manage textile waste. The process involves managing the outputs with Sewing house. The development of the Waste Bank management information system utilizes the Waterfall Method, with the Leaflet JavaScript Library for Open Street Maps visualization and the haversine method for finding nearby routes. Haversine is an effective algorithm for calculating distances between two points based on geographic coordinates on Earth's surface, used to determine the distance between two points on the globe from longitude and latitude coordinates. The result of this research is the waste bank website application, which assists Mojokerto City residents in finding the nearest waste bank locations, monitoring the distribution of waste bank, and real-time navigation using Google Maps.

INTRODUCTION

Information technology has become very common and has become a habit among people today. The existence of fast and easy information technology is expected to produce the information needed. Currently, information technology has presented a new innovation, namely the combination of information systems and geographic science, namely geographic information systems (GIS) which currently continues to develop along with advances in information technology. Geographic information systems can be used as information that refers to location specifications in a place, space, population and geographical elements contained on the earth's surface and displayed on a map in order to provide a more precise and accurate description of an object. Geographic information systems are widely used to make various decisions, design and analysis.

Data contained in the National Waste Management Information System shows that in 2023 there will be more than 17 million tons of waste generation throughout Indonesia. However, no more than 67% of this waste can be managed. The Department of Environment is located at Raden Wijaya Street Number.19, Prajurit Kulon Sub-district, Mojokerto City, East Java. Textile waste in Mojokerto city has not received more attention and has not been managed optimally by the local government community. Most of the textile waste was dumped in the randegan landfill in Mojokerto City.

Wiragatra comes as an innovation that helps the Environmental Service in managing textile waste. Wiragatra is a Management Information System Website for the waste bank and Geographic Information System for the nearest route search feature which aims to develop information for textile waste management and help reduce landfill waste in

Randegan Landfill, Mojokerto City. The purpose of the waste bank is to minimize the amount of waste that pollutes the environment and generate added value through textile waste recycling (upcycling). Donors will get points that can be exchanged for works in the Wiragatra shop. The development of the Wiragatra Waste Bank Management Information System is implemented with the Leaflet JavaScript Library to visualize maps sourced from Open Street Maps, the search for the closest route between the user's location and the waste bank location in this web GIS is applied the haversine method.

The Haversine Formula is used to calculate the great circle distance between two points on a sphere such as the Earth. This formula can be used to determine the distance traveled between two points on the surface of the Earth, for example to determine the distance between two cities or GPS positions. Meanwhile, Dijkstra's Algorithm is used to find the shortest path between two points in a graph. Dijkstra's algorithm is very commonly used in navigation and route optimization applications, such as finding the shortest path in a road map or transportation map. Based on the description above, researchers try to plan and design a Website Management Information System that can be a source of information on the distribution of waste banks in Mojokerto City. The results of the Wiragatra Website are expected to be useful for donors to care about the environment and manage textile waste properly.

WIRAGATRA WASTE BANK

Wiragatra is taken from 2 Indonesian words, Wira and Gatra, which means environmental warrior. Waste bank is a textile waste management system that involves the community to collect, donate, and manage waste generated in their neighborhood. The waste bank concept aims to reduce the amount of textile waste that goes to landfills. Solutions to the textile waste problem include upcycling or adding value to existing products. The meaning of upcycling itself is to utilize or reprocess unused goods by modifying and then adding value to the goods so that they have a selling value.

Figure 1. Wiragatra Waste Bank

TEXTILE WASTE

The textile waste managed is solid textile waste which is the remnants of the clothing and fabric production process. Solid textile waste is a serious environmental problem because it is difficult to decompose and often ends up in landfills or in the environment, causing pollution. The textile waste to be managed by Wiragatra includes Clothing and Perca Fabric. Handling solid textile waste is becoming increasingly important in an effort to reduce its negative impact on the environment. Initiatives such as recycling, upcycling, and public awareness education can help reduce the amount of textile waste that ends up in landfills.

Figure 2. Handicraft Exchange Shop

Wiragatra website mechanism starts with the donor bringing the clothes or rags to be donated to the waste bank then the donor accesses the website to find out the location of the waste bank using the nearest route search feature in the vicinity. After the donor arrives at the location of the waste bank, data collection will be carried out by the environmental service officer who is guarding it and weighing and inputting the weight of the donation to the points. Points collected by donors can be redeemed according to the nominal exchange there are placemats 200pts, Scrap Fabric Mats 400pts, Patterned Doormats 600pts and Used Fabric Bags 800pts.

RESEARCH METHOD

A method is an organized way used to achieve a certain goal or result. A method is the same as an effective way or step to solve a problem. Solving a problem with a method, one can reduce the waste of time, energy, and resources in the process of achieving a goal.

PROBLEM IDENTIFICATION

In this research, the process of problem identification through a survey of the case study location at the Mojokerto City Environmental Service. After conducting observations, interviews and data collection, researchers were given direction regarding the adjustment of Problem Identification with the innovation raised. That the Mojokerto City Environmental Service has promoted a waste reduction campaign by sorting organic and inorganic waste. Given, the growing waste production has resulted in waste piling up at Randegan landfill. Especially those from household waste. The Regional Head of Mojokerto City revealed that his party continues to strive to change the waste management system so that it does not only end up in the landfill. Because it tends to

pollute the environment. According to him, reducing waste production can be started by sorting. Namely by categorizing waste according to the type, amount and nature of the waste. If managed better, Household waste can still be used by sewing house.

Figure 3. Mojokerto City Environment Office

From various categories of waste, it was found that the waste problem that the researchers thought was relevant to the proposed innovation and the management output could be realized by working with sewing house was textile waste left over from clothes or rags. Researchers came up with the innovation of procuring a waste bank which aims to be a special distribution box for textile waste to be recycled. Efforts to help the Environmental Service and minimize the than optimal management of randegan landfill and also Reduce Reuse Recycle Waste Management in Mojokerto City.

OBSERVATION

Observation or direct observation in this study is to observe the Environmental Service Raden Wijaya Street No.19, Prajurit Kulon Sub-district, Mojokerto City, East Java. Which aims to obtain the information needed and find out the flow or process related to textile waste donation that runs.

INTERVIEW

Researchers conducted interviews and asked questions directly related to the research topic to the Environmental Service. In this case the researcher conducted an interview with Mr. Daryono who holds the position of staff environmental department. With interviews conducted, researchers can find out information and can formulate the need to build a waste bank management information system and search for the closest route in Mojokerto City. It is intended that the website-based management information system developed later is truly appropriate.

LITERATURE STUDY

Literature study is useful as a theoretical study for research that is being carried out by researchers because it is to underlie the testing and development that will be carried out. Researchers take from journals, books and articles related to geographic information systems that use the Leaflet JavaScript Library for Open Street Maps visuals and the haversine method for the closest route. So it is hoped that later it can help researchers about development and testing in carrying out research.

SYSTEM DESIGN

The development of the Wiragatra Waste Bank Management Information System followed the Waterfall methodology, ensuring a structured and sequential approach. The key stages included:

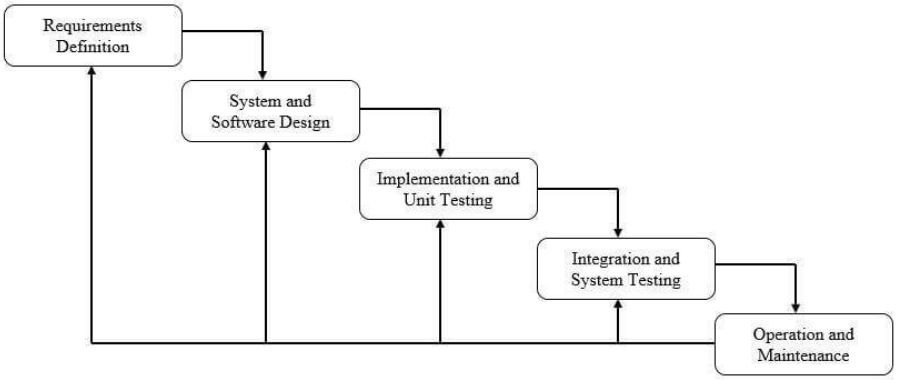


Figure 4. Metode Waterfall

Source: https://ranahresearch.com/metode-waterfall/

1. **Requirement Definition:** Collecting needs from the case study of the Mojokerto City Environmental Service through observation and interviews to find out what needs are needed in building the Wiragatra system.
2. **System Design:** Using the Leaflet JavaScript Library for map visualization and implementing the Haversine method to calculate the shortest routes to nearby waste banks.
3. **Implementation:** Developing the system using the Laravel framework for back-end processes and integrating GPS for real-time location tracking and user authentication.
4. **Testing:** Conducting extensive testing, including black-box testing to evaluate system functionalities and User Acceptance Testing (UAT) to ensure the system meets user expectations.
5. **Operation & Maintenance:** This stage also be interpreted as a form of responsibility to ensure that the system can run smoothly and also to improve system capabilities.

RESULTS AND DISCUSSION

The results section simply and objectively reports what the researcher found, without speculating on why the researcher found these results. The discussion interprets the meaning of the results, puts them in context, and explains why they are important.

SYSTEM IMPLEMENTATION

In implementing the system, researchers designed and developed a website-based waste bank management information system application in Mojokerto City with a waterfall system development or approach and for the closest route search using the haversine formula method. 3 actors involved in this system include admin, officers and donors who have their own access and views. In the implementation stage, map visualization uses Leaflet JavaScript Library, digital maps sourced from Open Street Maps and website support using the Laravel framework. Realtime navigation output is directed to Google Maps.

HAVERSINE FORMULA CALCULATION

To calculate the distance between two points on the Earth's surface given their geographical coordinates (latitude and longitude), we can use the Haversine formula. This formula accounts for the spherical shape of the Earth and provides accurate results for long distances on the Earth's surface. Here are the steps and explanations of this calculation:

First, we need to calculate the change in latitude (Δlat) and the change in longitude ($\Delta long$). Δlat is the difference between the latitude of the second point ($lat2$) and the latitude of the first point ($lat1$), while $\Delta long$ is the difference between the longitude of the second point ($long2$) and the longitude of the first point ($long1$).

Second, we use the Haversine formula:

$$a = sin^2\left(\frac{\Delta lat}{2}\right) + cos(lat1) \cdot cos(lat2) \cdot sin^2\left(\frac{\Delta long}{2}\right) \text{ (1)}$$

Where a is a value between 0 and 1 calculated based on the changes in latitude and longitude as well as the cosine of the latitudes of both points. Next, we calculate the value of c using the inverse tangent function with two parameters, which helps in computing the angle from the value of a:

$$c = 2 \cdot atan2\left(\sqrt{a}, \sqrt{1-a}\right) \text{ (2)}$$

Finally, to get the distance (d) between the two points, we multiply the value of c by the radius of the Earth (R), which is approximately 6371 km:

$d = R \cdot c$

Where:

- R is the radius of the Earth, which is 6371 km.
- Δlat is the amount of change in latitude.
- $\Delta long$ is the magnitude of change in longitude.
- c is the axis intersection calculation.
- d is the distance in kilometers

It is important to note that for calculations using the Haversine formula, one degree must be converted to radians, which is equivalent to 0.0174532925 radians per degree.

BLACK BOX TESTING

Black box testing is a software testing method that focuses on the functionality side, especially on the input and output of the application (whether it is as expected or not). This testing stage is one of the stages that must exist in a software development cycle. With this black box testing, it is hoped that if there are errors or deficiencies in the application, researchers can find out as early as possible.

USER ACCEPTANCE TESTING (UAT)

UAT testing is a testing process by users which is intended to produce documents that are used as evidence that the system developed is acceptable or not by the user, if the test results can be considered to meet the needs of the user then the application can be implemented. Testing with UAT is done by asking several questions to agency employees who act as users, this test involves 10 staff environmental department (Daryono, Ika Seftiarini, Lilis Sugiyarni, Agus Zainal, Sulistyo Wahyudi, Anjiatno, Marjuki, Robit Fuadzi, Nonik, Syahrul Badri).

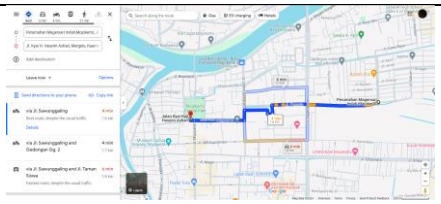
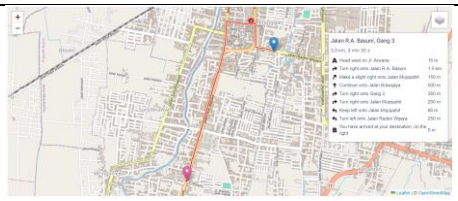
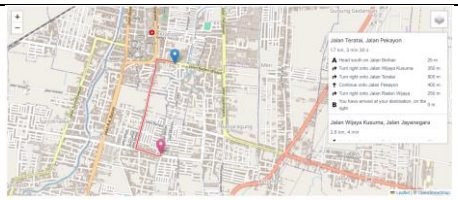
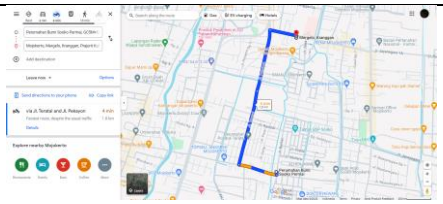
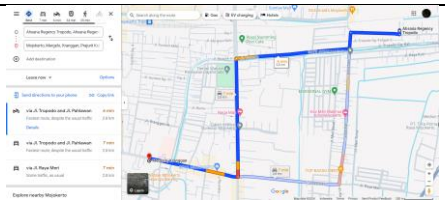
TESTING SAMPLE

Wiragatra Website Customization Sample regarding the closest route search between Open Street Maps and Google Maps.

Table 3.1. Housing Sample in Mojokerto

No	Address	Latitude	Longitude
1	**Mutiara Garden Housing** Banjar Mlati, Lengkong, Mojoanyar, Mojokerto Regency, East Java 61364	-7.450266665407423	112.46748412003461
2	**Magersari Indah Housing** Pisang Street No.63-81, Mergelo, Wates, Magersari, Mojokerto City, East Java 61317	-7.462750250816446	112.44432551678537
3	**Wisma Sooko Indah Housing** R.A Basuni Street No.83, Sooko, Mojokerto District, East Java 61361	-7.495836378249211	112.42425193085323
4	**Bumi Sooko Housing** Berlian Street, Mergelo, Sooko, Mojokerto District, East Java 61361	-7.491410485246065	112.43261012693156
5	**Ahsana Regency Tropodo** Tropodo Street, Mergelo, Magersari, Mojokerto City, East Java 61315	-7.472857635888468	112.4502510636483

Table 3.2. Wiragatra Nearby Box Testing Sample with Google Maps

No	Nearby Box Wiragatra	Google Maps	Description
1			Suitable
2			System Finds the Nearest Route
3			Google Maps Finds the Nearest Route
4			Suitable
5			Suitable

MAINTENANCE

The last stage in the waterfall method is the operation and maintenance of the system. System maintenance is carried out in stages on a system that has been finished and used by users. Developers can make improvements to system errors that were not detected in the previous stages. System maintenance includes error correction, system upgrades and system adjustments to the needs and perhaps there are additional suggestions from the Mojokerto City regarding the development of this Wiragatra system.

CONCLUSION

The designed management information system can assist the Mojokerto City Environment Office in managing textile waste, user data, and monitoring the distribution of Wiragatra waste bank locations. In addition, the developed Wiragatra website aims to

help donors find the distribution of Wiragatra waste banks by calculating the distance between two points using coordinates based on the length of a straight line on longitude and latitude, which implements the nearest route search from the Haversine method. Real-time navigation results are directed to Google Maps.

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Enhancing Web-Based Diabetes Prediction Using Random Forest Optimization and SMOTE

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Keywords:
diabetes, information system, random forest, smote, flask framework

ABSTRACT

This research develops a website-based diabetes early detection information system using random forest method and synthetic minority oversampling (SMOTE) technique. This system is designed to predict the risk of diabetes based on user-inputted symptoms. Flask framework is used to optimize web application development. System testing was conducted using black box testing method and validation by medical experts, showing accurate prediction results. The use of the Flask framework facilitates the integration of modeling and user interface development. The data used in this research was balanced using SMOTE, resulting in a prediction accuracy of 96%. The results show that this information system is effective in providing early prediction of diabetes risk and can be a tool for the community to increase awareness of the importance of periodic health checks. The system also provides information that can be used to take preventive measures against diabetes mellitus, supporting government efforts to improve public health.

INTRODUCTION

Indonesia is a country with a population of 271.9 million according to WHO data in 2020. With a birth percentage of 77%. With the number 4 population in the world, the mortality rate in Indonesia is still relatively high with the main cause of chronic diseases suffered. According to WHO data, the highest causes of death in Indonesia are stroke, ischemic heart disease, and followed by diabetes mellitus in third place with a range of 43 per 100,000 population in women and 39 per 100,000 population in men (data.who.int, 2020). According to the Indonesian Ministry of Health, it is predicted that the level of vulnerability to diabetes in Indonesia could reach 30 million people by 2030. It cannot be denied that diabetes mellitus, which is a chronic condition due to problems with insulin production, can affect individuals in all age ranges, from children to the elderly, supported by analysis of diet and lifestyle (Lestari et al., 2021).

There are two types of diabetes in the world, namely type 1 diabetes which is caused by gene abnormalities resulting in a condition where the body cannot produce insulin at all, then type 2 diabetes which is caused by the body's failure to respond to insulin as a whole so that insulin cannot work properly. Looking at the report released by the International Diabetes Federation (IDF) in 2022, the number of people with type 1 diabetes mellitus in Indonesia reached 41.8 thousand people. This makes Indonesia the country with the most type 1 diabetes mellitus sufferers in ASEAN and ranked 34th on an international scale, this figure is 10% of the total Diabetes Mellitus sufferers in Indonesia because 90% of all diabetes mellitus sufferers are type 2 diabetes mellitus sufferers. From IDF statistics, most patients are in the age range of twenty to fifty-nine years, with a graph at a young age that looks quite high (Ahdiat, 2023). Diabetes mellitus is a disease categorized as a chronic disease characterized by changes in the body's performance in the metabolic process of carbohydrates, fats, and proteins, causing blood sugar levels to rise. This can be detected through the sugar content in the patient's urine which is not controlled (Mohajan & Mohajan, 2023).

This disease is feared by the community so that it has the nickname The Great Imitator, a disease that can damage all organs of the body after becoming a patient suffering from it. The damage in the body comes slowly so that patients with diabetes mellitus cannot feel and realize the various changes that occur in their bodies (Ahlin & Billhult, 2012). In the current era, lifestyle is a secondary need that depends on the era. People's lifestyle today tends to ignore the condition of their body's health by having a diet that is high in fat, salt and sugar. These ingredients are found in fast food, coffee and sugary drinks, and excessive cigarette use. Meanwhile, to control blood sugar to remain stable, people are encouraged to reduce food portions, maintain a diet, and set a stable eating schedule (Medina-Remón et al., 2018).

Organizing a healthier diet and lifestyle by exercising regularly, reducing cigarette use, and maintaining a good diet can reduce the development of diabetes mellitus in the community. Seeing the increase in the graph of diabetes mellitus patients per year, there are still many people who complain about the health services provided by the government through the BPJS program. What should be the government's media in monitoring public health and community service media for periodic health checks is currently experiencing a lot of maladministration where there is an imbalance between BPJS user patients and independent patients or insurance users. Maladministration in the provision of health services is due to the absence of standards or regulations from the government so that many health service people take advantage of this by committing maladministration (ombudsman.go.id, 2023). This action has caused the community to lose interest in checking their health conditions regularly with the health service so that the process of diagnosing diabetes in the community is delayed.

Therefore, a website-based detection information system was developed that aims to be an early detection of diabetics by utilizing the dataset that has been collected as user comparison data. This system is designed to provide diabetes risk prediction to users based on the symptoms inputted through the form so that it can help the community in detecting the risk of diabetes early and increase awareness of the importance of regular health checks. The information system was developed using the random forest method and synthetic minority oversampling technique as a detection method by utilizing the development of an expert system to diagnose diabetes mellitus based on the symptoms that arise in the user through a form that will be filled in by the user. The dataset used has 18 features that are used as a data analysis model so that the system can predict diabetes diagnoses in users. The development of the random forest method in diabetes prediction information systems is based on reference to previous research journals with the title "Machine Learning Based Diabetes Prediction and Development of Smart Web Application". The journal has several machine learning methods studied and one of them is random forest. The accuracy value obtained from each method does not have much difference, but the highest accuracy value is obtained from the random forest method. There are two datasets used in the research and from these two datasets the four highest accuracy values appear, namely SVM and Random Forest on dataset 1 and Decision Tree and Random Forest on dataset 2 (Ahmed et al., 2021).

RESEARCH METHOD

This research is designed with several stages of methodology adapted from the IBM analysis method (Rollins, 2015) and the Waterfall development method (Bassil, 2012), namely the problem analysis stage, model development, website development, and reporting. The research flow is organized as in Figure 1.

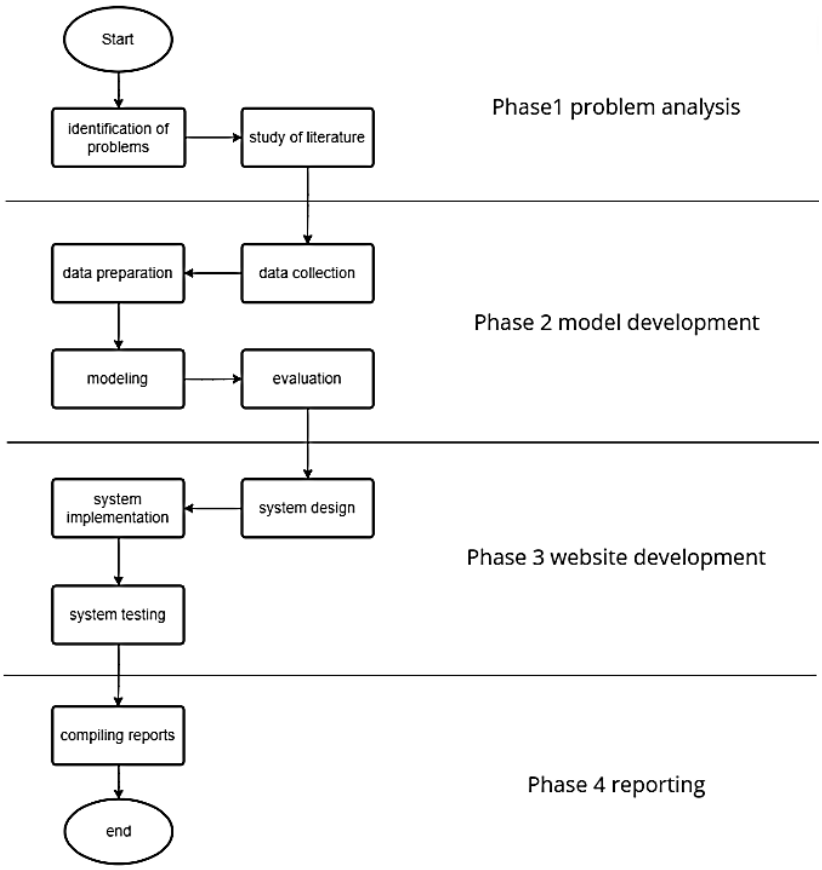


Figure 1. Research Flow

2.1 Phase I Problem Analysis

The initial stage of this research is problem analysis, in problem analysis the researcher will choose a topic, determine the formulation of the problem, objectives, and conduct a literature study for the topic of diabetes, random forest algorithms (Nudin et al., 2022), and synthetic minority oversampling technique (SMOTE) (Chawla et al., 2002). This stage has two processes, namely identification of problems and study literature.

2.2 Phase II Model Development

Stage two is model development. This stage is adapted from IBM Data Science Methodology and there are four processes for its development. At this stage the data will be processed into a data model that is used for data analysis using the random forest algorithm and SMOTE technique. The four development processes are data collection, data preparation, modelling, and evaluation. The authors collect various dataset provided by the official international dataset website, Kaggle.com. The dataset used is Neha Prerna Tigga's dataset with the title "Diabetes Dataset 2019". This dataset has 18 features with 954 respondents (Tigga1, 2019). After obtaining the data, the authors will

examine the data to identify problems in the data obtained with three preparatory processes, namely cleaning data, combining data, and transforming data. Random forest algorithm as a modeling technique, the algorithm will be implemented in the python programming language and integrated into a web-based diabetes prediction information system. The selection of the algorithm is obtained from the reference journal literature with the title "Machine Learning Based Diabetes Prediction and Development of Smart Web Application". The literature compares various machine learning algorithms with the highest result being the random forest algorithm on the two datasets tested. The modeling stage begins with training data on the random forest algorithm to build a model. After carrying out the modeling stage, an evaluation stage is needed to determine whether the model that has been used can run in accordance with the original research objectives. At this stage, testing the model used with the confusion matrix method is carried out to produce several values (Santra & Christy, 2012).

1. True Positive (TP): how much data is actually labeled positive and how much the model predicts the label is positive.
2. True Negative (TN): how much data has an actual negative label and how much the model predicts an actual negative model.
3. False Negative (FN): how much data is actually labeled negative and how much the model predicts is actually positive.
4. False Positive (FP): how much data has an actual positive label and how much the model predicts an actual negative model.

Through the above data, it can allow researchers to calculate the probability of the quality of the model used through the calculation of the model's confusion matrix value with the formula:

1. Accuracy: The overall total of the model classifies the data accurately. The following is the formula for calculating the accuracy value:

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

2. Precision: The accuracy value between the requested data and the prediction results given by the model. The following is the calculation formula:

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

3. Recall: The value of the model's success in retrieving information. The following is the calculation formula:

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

4. F1-Score: The average value of the results of the precision and recall calculations. The following is the calculation formula for f1-score:

$$F1\text{-}Score = 2\ x\ \frac{precision\ x\ recall}{precision+recall} \quad (4)$$

2.3 Phase III Website Development

The process of developing this diabetes prediction information system uses a waterfall model. This model has an initial stage before entering system design, namely system requirements analysis, this stage aims to narrow down existing problems and analyze

system development needs. Before conducting research, the authors must identify the problems that will be raised in the topic. After getting the identification of the problem above, the authors will create a website-based diabetes prediction information system. The information system is to predict diabetes in users so that users can more easily diagnose diabetes. The system analysis will be used as follows in Table 1.

Table 1. System analysis

Hardware	HP 14s laptop, AMD Ryzen 5 5625 with Radeon Graphics, Windows 11 64 Bit, 8.00 GB RAM
Software	Microsoft Office Word 2021, Microsoft Excel 2019, Visual Studio Code, Figma, google colab
Input Data	Diabetes diagnosis indicator form
Output data	Diabetes diagnosis prediction results
Result	No diabetes, Diabetes

After understanding and analyzing system requirements, researchers proceed to the next stage, namely system design to system testing. The flow of how this diabetes prediction information system works is available at Figure 2. The first stage user will fill out the form according to the user's health condition through the website, the second stage information that has been provided by the user will be sent to the back-end website, the third stage Flask server will perform analysis and provide prediction results from data analysis through the random forest method, fourth stage the website displays the prediction results to the user.

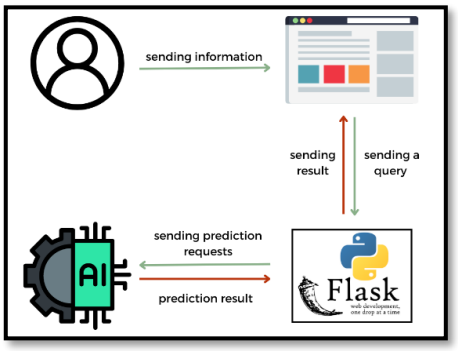


Figure 2. Working Flow Website

There are two stages of testing carried out by the authors are interface testing and validation testing.

1. Interface Testing

Testing the interface / user interface aims to find out the performance of the tools on the website can be used as expected by the authors. There is a test plan for the system interface, namely:

- The home feature is expected to bring users to the description of diabetes on the main page.
- The data input form is expected to be filled in according to the predetermined data type
- The prediction button is expected to display the results of predictions made by the system

2. Validation Testing

Validation testing aims to determine the match between the test results carried out by experts and the results of the analysis carried out by the system. The validation will be carried out by two expert experts as a parameter for the match between the doctor's analysis and the results of data analysis. Testing is done by entering analysis parameters according to the form on the prediction information system to determine the accuracy of the expert system and a questionnaire with yes / no answers to test the feasibility of the system.

2.4 Phase IV Reporting

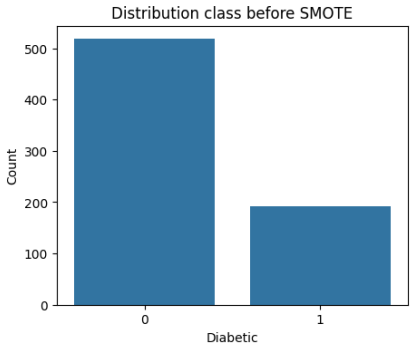
The reporting stage is the final stage of the research at this stage in the form of the process of preparing the final project report. The process of preparing this report includes several important steps that must be followed carefully to ensure the report is comprehensive, accurate, and in accordance with established guidelines. The research results and discussion will be presented in the form of tables, graphs, or clear and informative narrative descriptions, analyzing the research results, relating them to existing theories, and explaining the implications of the findings. In the conclusion section, the authors summarize the main findings of the research and provides relevant recommendations based on the results obtained.

RESULTS AND DISCUSSION

Model development is made through the google collab application with data collection from Kaggle. Website development is made through the vscode application with the flask framework for website display and integration with data analysis modeling (Musse Bekabil, 2014). The following is an explanation of both points 3.1 until 3.3.

3.1 Model development

Based on the images in Figure 3 and Figure 4 before implementing the smote technique, the amount of data for diabetics and non-diabetics is drift about 300 data and after implementing the smote technique, the data for diabetics and non-diabetics is equal in each class with total of 500 data.



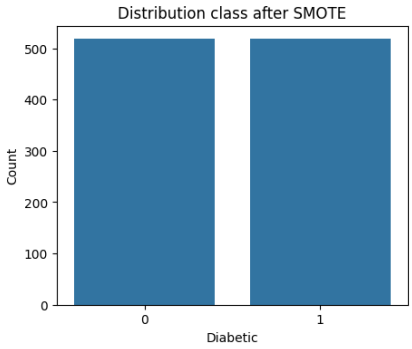


Figure 3. Distribution class before smote **Figure 4.** Distribution class after smote

From the visualization of Figure 6, it can be seen that according to the mapping of the confusion matrix method obtained by the test data as much as 237 data has an accuracy of 0.96 or 96%. This fig.6 diagram visualization determines the loss value of the test data as much as 5 in non-diabetes data and 5 in diabetes data, the value with red and beige

color blocks means that the value of valid data with a total of 159 non-diabetes data and 68 diabetes data. From the visualization of Figure 5, it can be seen that according to the mapping of the confusion matrix method obtained by train data as much as 1021 data has an accuracy of 0.99 or 99%. Visualization diagram Figure 5 determines the loss value of the test data as much as 9 in non-diabetic data and 6 in diabetic data, the value with the beige color block means that the value of valid data with a total of 512 non-diabetic data and 509 diabetic data. the data has undergone oversampling made with the smote technique.

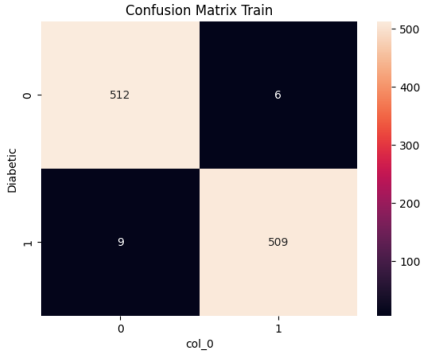


Figure 5. Confusion matrix of train

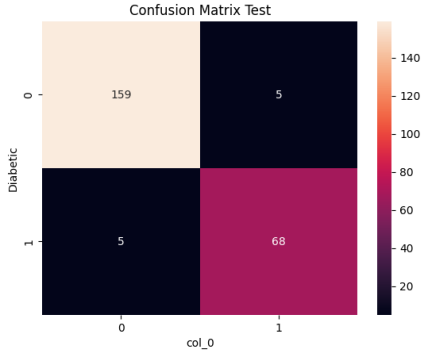


Figure 6. Confusion matrix of test

3.2 System implementation

The development of the diabetes prediction information system is adapted from the waterfall method. The initial stages of system analysis, system design, and wireframe of the system have been discussed in research methodology. The next stage is system implementation by creating the interface of the prediction information system and integrating it into the data analysis modeling that has been made in the previous stage. The following is the display of the diabetes prediction information system website.

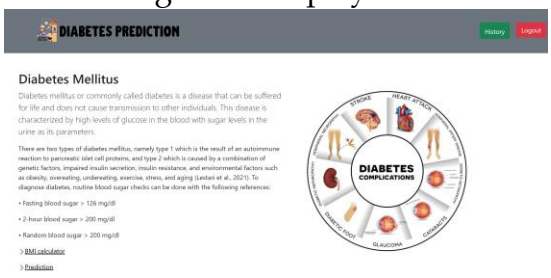


Figure 7. Basic summary

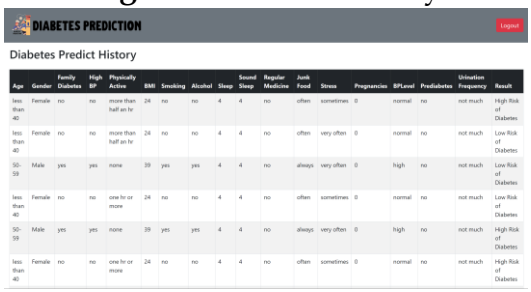


Figure 9. Result history

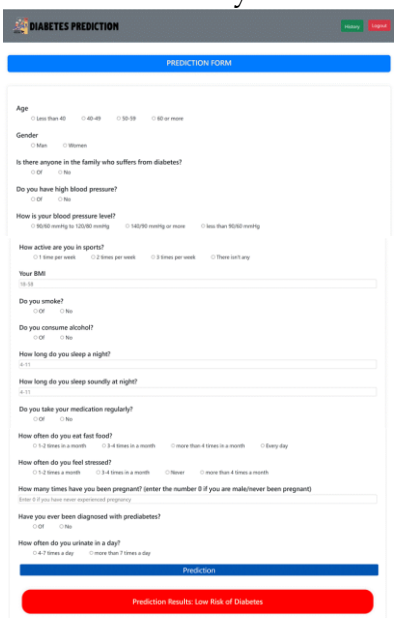


Figure 8 Form predict and result

3.3 System testing

In validation testing, there are two test forms, namely the expert system accuracy feasibility test and the system feasibility test. The following are the test results from both

stages. The testing through experts by comparing the results of system predictions with the results of expert diagnoses. Comparison of diagnostic results can have results that are not the same as each other. This depends on the user filling process on the prediction form and modeling performance.

Table 2. Results of expert system accuracy test

No	Testing	Parameters	Answer	Result System	Diagnoses Doctor
1	Uji 1	Age	40-49	High Risk of Diabetes/ ~~Low Risk of Diabetes~~	High Risk of Diabetes/ ~~Low Risk of Diabetes~~
		Gender	Female		
		family diabetes	yes		
		high blood preasure	no		
		physically active	3-4 times per week		
		BMI	25		
		Smoking	No		
		Alcohol	No		
		Sleep	6		
		sound sleep	6		
		regular medicine	No		
		junkfood	3-4 times a month		
		stress	1-2 times a month		
		blood preasure level	90/60 - 120/80		
		pregnancies	3		
		pdiabetes	yes		
		urination frequency	4-7 times a day		
2	Uji 2	Age	40-49	High Risk of Diabetes/ ~~Low Risk of Diabetes~~	~~High Risk of Diabetes~~/ Low Risk of Diabetes
		Gender	Female		
		family diabetes	not		
		high blood preasure	No		
		physically active	3-4 times per week		
		BMI	23		
		Smoking	No		
		Alcohol	No		
		Sleep	6		
		sound sleep	6		
		regular medicine	No		
		junkfood	1-2 times a month		
		stress	Never		
		blood preasure level	90/60 - 120/80		
		pregnancies	6		
		pdiabetes	yes		
		urination frequency	4-7 times a day		

Table 2 above is an expert system feasibility test table by filling in the expert diagnosis column and will be compared with the system prediction results. Of the two tests, there is one invalid test because the test results are not the same as each other. This is because

filling in the pdiabetes column is not in accordance with the dataset used so that the model cannot provide good analysis. Table 3 below is an information system feasibility test table, the table is filled in by giving a check mark in the column provided with four assessment categories, namely NS (not suitable), LS (less suitable), S (suitable), and VS (very suitable). The test table is filled in by expert who also validate the results of system predictions. The following is a table of information system feasibility test results based on expert.

Table 3. System feasibility testing results

Testing	Question	Scoring Category			
		NS	LS	S	VS
Test 1	System Purpose			√	
	Features of the system			√	
	Order of presentation			√	
	Suitability of the symptoms asked			√	
	The suitability of the prediction results given with the results of expert diagnosis		√		
	Alignment of questions with prediction results			√	
Test 2	System Purpose			√	
	Features of the system			√	
	Order of presentation			√	
	Suitability of the symptoms asked		√		
	The suitability of the prediction results given with the results of expert diagnosis			√	
	Alignment of questions with prediction results		√		

CONCLUSION

In this final project, the authors develop a diabetes prediction information system using Random Forest and SMOTE methods to overcome data imbalance between "diabetes" and "non-diabetes" results. SMOTE is used to equalize data values to improve accuracy, recall, and f1-score. Random Forest algorithm was chosen because it is more complex and optimal than Decision Tree, as described in the journal "Machine Learning Based Diabetes Prediction and Development of Smart Web Application". Model evaluation using confusion matrix showed an accuracy of 96%. This system is proven to be accurate in predicting new data entered through the form on the website. Some of the supporting modules installed include Flask, virtual environment, and others. The file `__init__.py` is required to initialize Flask and ensure the data structure and folders are in accordance with the Flask framework. Based on the results, although the accuracy reached 96%, there is still room for improvement. It is recommended to expand and increase the dataset and implement better optimization. This is expected to improve the accuracy and quality of information system predictions. Improving methods and optimization is also important to improve the prediction results in this diabetes prediction information system.

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Web-Based Property Value Prediction Utilizing Random Forest Algorithms

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Keywords:
Property price prediction
Machine learning
Random Forest algorithm
Web-based system
Laravel frameworks

ABSTRACT

Property price prediction is a complex problem and has many influencing factors. The lack of applications that can facilitate property appraisers in predicting property values makes it difficult know prices quickly and accurately, so that it can disrupt the balance and efficiency of the property market. Research with the title Development of a Web-based Property Value Prediction System can provide a clearer picture or recommendation about the selling value of property in Surabaya based on physical characteristics, position and location. This research was conducted using one of the machine learning algorithm models, namely Random Forest for data processing and modelling. The data used includes information about land area, road width, designation zone, and indication of land value. The results of the prediction will be displayed on the website by utilising the Laravel frameworks. Evaluation of the developed model showed promising results, with an accuracy of 83% in predicting property values. This shows that the system has the potential to help property appraisers determine property values more effectively.

INTRODUCTION

The property market is a place where people buy, sell, or rent properties, such as houses, apartments, land, and commercial buildings. In the property market, sellers offer their properties at a certain price, and buyers look for properties that suit their needs and budget. The property market has evolved to be more than just a place to live or a place to do business [1]. Investment in property has become one of the most significant and far-reaching forms of investment, covering residential, commercial, and industrial segments. Property price prediction is one of the important issues in real estate and finance.

Property prices are influenced by various factors such as location, size, shape, and surrounding facilities [2]. Accuracy in predicting property prices is very important for homeowners, investors, and real estate agents to make the right decision in buying or selling property [3]. Therefore, the development of reliable prediction models is the focus of much research in this area. Machine learning algorithms are often used to predict property prices. Among the many existing algorithms, Random Forest is one of the most effective.

Random Forest uses multiple decision trees simultaneously to improve the accuracy and stability of predictions [4]. Previous research shows that Random Forest has significant advantages over traditional methods such as linear regression. Random Forest is able to produce more accurate predictions and is more resistant to overfitting than linear regression. In addition, Random Forest is more effective in handling data with many features and interactions between features. However, there are still challenges in applying Random Forest for property price prediction.

In addition, the selection of appropriate parameters for Random Forest, such as the number of trees and maximum depth, is crucial to achieve optimal performance. This research aims to address these challenges and evaluate the performance of Random Forest in the context of property price prediction. To achieve this goal, this research uses an extensive and diverse property transaction dataset, covering a wide range of relevant

features. This dataset is processed through several stages, including data cleaning, categorical feature coding, and normalization.
Random Forest models were then trained and evaluated using metrics such as Mean Absolute Error (MAE), Root Mean Squared Error (RMSE), and R-squared (R^2). The results of this study are expected to provide deeper insights into the effectiveness of Random Forest in predicting property prices and make important contributions to the development of more accurate prediction models.

1.1 Random Forest Model

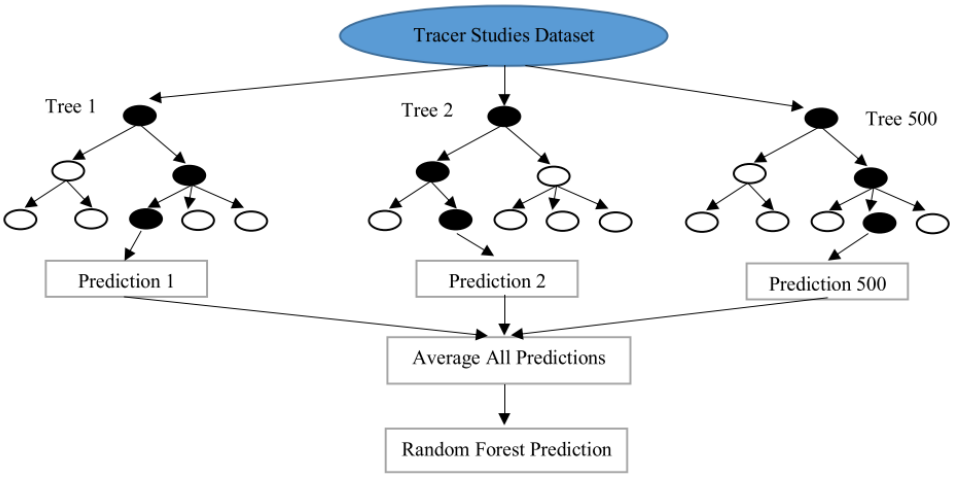

Fig. 1. Prediction of Random Forest Model
Source: (*S. R. Nudin et al*, 2022)

There are two techniques used to develop the Random Forest model: bagging and random subspace. Bagging involves taking bootstrap samples and combining the models learned from each sample. Bootstrapping is a statistical method of random sampling with replacement used to manage unbalanced data [5]. In the Random Forest model, the nodes in each decision tree are randomly assigned to select attributes from a random subspace. The use of bagging and random subspaces helps the Random Forest model manage overfitting more effectively than a single decision tree [6]. Generally, developing a Figure 1 involves four steps:

1. Using the bootstrap method to create a random sample that is the same size as the training dataset or the full dataset.
2. Employing the random subspace method to select K attributes from a total of M attributes, where K << M (typically, K is chosen to be equal to the square root of M).
3. Building a decision tree using the bootstrap sample and selecting attributes from steps 1 and 2.
4. Repeating steps 1 to 3 to construct multiple trees until the desired Random Forest is achieved.

The out-of-bag (OOB) error rate is used to determine the number of trees in the Random Forest.

1.2 Property Theories

As is well known, there are various bases used to assess the quality of a property. While there are several theories that can be applied, not all property theories are explained in this subchapter as they are too diverse. Therefore, only the basic theories used in the manufacturing process will be discussed. The following are the theories used:

- **Property Position**

There are 4 positions in this system. Interior position, this position is the most popular position because it can have two directions. Corner position, this position is still classified as a position that is quite popular, namely the position at the end. Kuldesak position, this position is a position that surrounds the park, or is at the entrance to a housing estate and the position of a skewer, this position is what prospective buyers usually avoid due to myths that exist in the community. But the position of the property cannot determine the price of the property because the quality of the property depends on the condition of the property [7].

- **Property Shape**

The shape and dimensions of a property are what determine a property the most. There are land shapes such as square, rectangle, triangle, trapezoid, and others that may occur. This is supported by the size of a property's land such as the length and width of the square metre.

- **Property Designation**

- **Residential zone / Housing:** Spatial designation consisting of groups of residential houses that accommodate the lives and livelihoods of people equipped with facilities.
- **Protected Forest**: Spatial designation which is part of a protected area that has the main function as protection of life support systems to regulate water systems, prevent flooding, control erosion, prevent seawater intrusion, and maintain soil fertility.
- **Green Open Space**: An elongated / striped and / or grouped area, the use of which is more open, where plants grow, both naturally growing plants and those that are deliberately planted.
- **Trade and Service Zones**: Spatial designations that are part of cultivation areas functioned for the development of commercial business activities, places of work, places of business, and places of entertainment and recreation, as well as supporting public/social facilities.
- **Industrial Zones Industry**: is an economic activity that processes raw materials, raw materials, semi-finished goods, and/or finished goods into goods with higher value for their use, including industrial design and engineering activities.
- **Other Designation Zones**: Spatial designations developed to accommodate activity functions in certain areas in the form of agriculture, mining, tourism, and other designations [8].

RESEARCH METHOD

Figure 2 is the section of Method explains how the research is conducted, research design, as well as techniques of data collecting and analysis. The following descriptions are guidance to set the page layout and text format of overall manuscript.

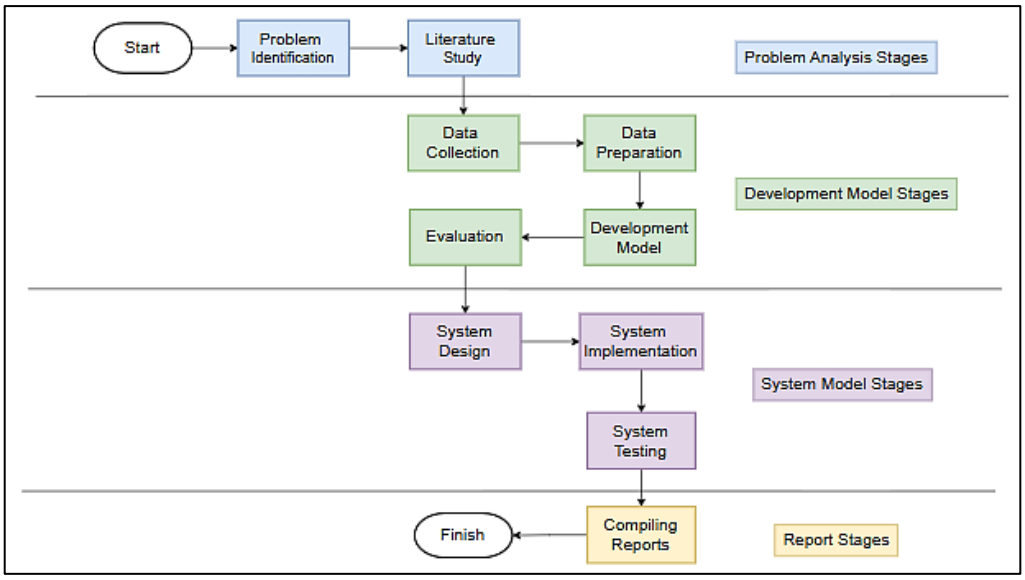

Fig. 2. Research Flow

2.1 Model Development

There are several stages of model development carried out to process the required data, such as data collection, data pre-pocessing.

2.1.1 Data Collection:

The data used in this study is property transaction data obtained from various sources, including appraiser. The dataset includes features such as land area, number of rooms, location, and selling price. The data is collected in CSV format to facilitate further analysis.

2.2.1 Data Pre-processing

Data pre-processing is done to improve the quality of the dataset and ensure the model can work optimally. As shown in table 1, which displays the features of the dataset we used consisting of Longitude, Latitude, Road Row, Designation, Shape, Property Location, Land Area, Building Area, Quantity of Bathrooms and Quantity of Bedrooms.

Table 1. Property dataset features

No	Fitur	Type Data
1	Longitude	Integer
2	Latitude	Integer
3	Road Row (m)	Integer
4	Designation	Text
5	Shape	Text
6	Property location	Text
7	Land Area	Integer
8	Building Area	Integer
9	Bathrooms	Integer
10	Bedrooms	Integer

The pre-processing steps include:

a. **Data Cleaning**: Removing missing values and dealing with data duplication [9].
b. **Categorical Feature Coding**: Converting categorical data (such as location) into numerical data using one-hot encoding techniques.
c. **Data Normalization**: Scaling numerical features to ensure that all features are in the same range, using methods such as Min-Max Scaling.
d. **Random Forest Model Training**: The Random Forest model is trained using the training data. The training process involves:
   - Initial Parameter Selection: Setting initial parameters such as number of trees (n_estimators) and maximum depth of trees (max_depth).
   - Parameter Optimization: Using Grid Search, Random Search and Halving Grid Search techniques to find the combination of parameters that gives the best performance. The optimized parameters include n_estimators, max_depth, min_samples_split, and min_samples_leaf.
e. **Model Evaluation**: The trained model was evaluated using test data [10]. Several evaluation metrics are used to assess model performance, including:
f. **Mean Absolute Error (MAE)**: Measures the average absolute error between the predicted price and the actual price. The formula 1 for calculating MAE.

$$\text{MAE} = \frac{1}{n}\sum_{i=1}^{n} | yi - yi | \qquad (1)$$

g. **Root Mean Squared Error (RMSE)**: Formula 2 is used to measure the average squared error between predicted price and actual price

$$\text{RMSE} = \sqrt{\frac{\sum_{(Actual-predict)^2}}{n}} \qquad (2)$$

h. **R-squared (R^2)**: Formula 3 is used to measures how well the model explains the variability in the data.

$$R2 = 1 - \frac{\sum(yi-y)^2}{\sum(yi-y)^2} \qquad (3)$$

2.2 Website Development

This system is built in the form of a website, so that users can easily access and use this prediction system from anywhere. The system design includes the user interface and the process behind the website screen, how the data is inputted and processed, and how the prediction results are displayed to the user.

- **System Architecture**

  To develop a website-based property value prediction system that implements Random Forest prediction, there are several parts of the system. Property appraisers in this case act as users will access the website-based property value prediction application to input data and view prediction results with the flask framework for the frontend. Then the history of the data that has been inputted will be stored in the MySQL database which will later be used in the backend for the prediction, evaluation, and graphics process using Python and google collab as well as for the implementation of the random forest model.

- **Use case :**

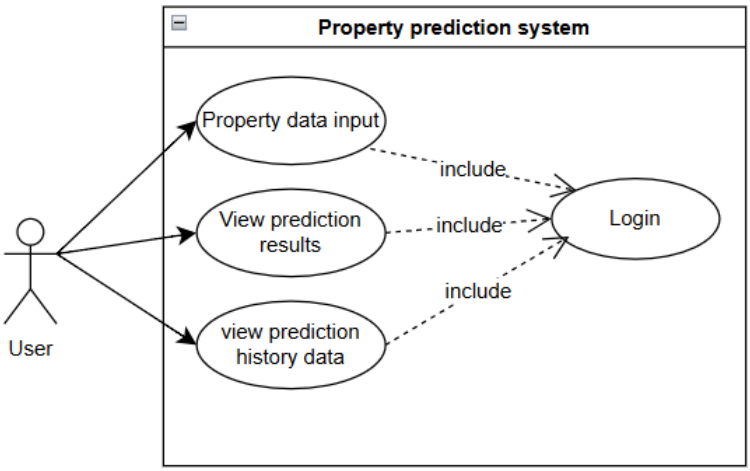

Fig. 3. Use Case System

Use case on Figure 3 diagram shows the relationship that occurs between actors and use cases that have each of their respective functions in a system. Where a user performs several stages such as login, dataset input, viewing data and graphs, and viewing prediction results as well as seeing the evaluation of the model that has been made.

- **User Interface Web:**

- Design of prediction feature page

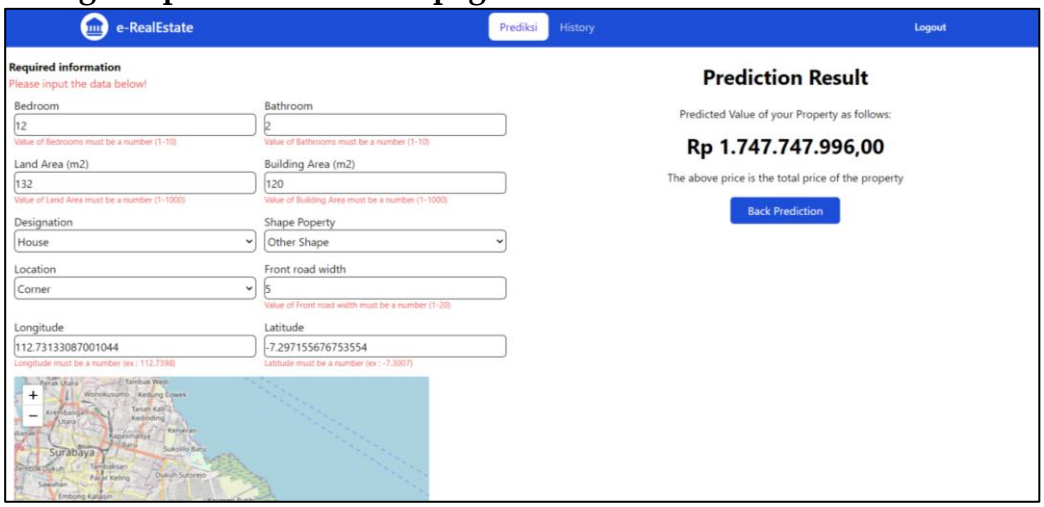

Fig. 4. Prediction Page

Design of prediction feature display On Figure 4. there are features consisting of several inputs to create a new dataset that will be processed and features of property value prediction results. The required inputs are coordinate points, address, property location, property shape, zone designation indication of permeter value and property area.

- **Design of overview feature page**

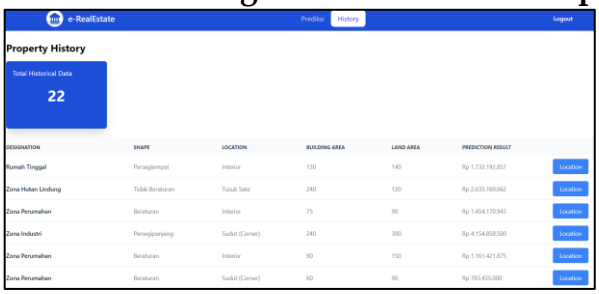

Fig. 5 History page

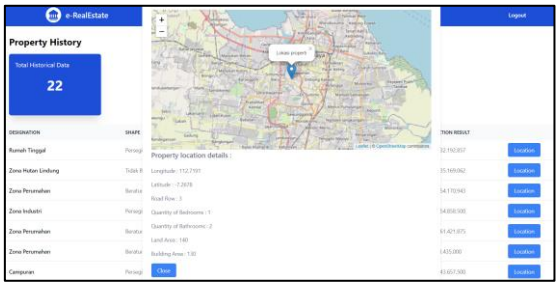

Fig. 6 Location Page

On Figure 5 there is a history of data that has been predicted before, which is displayed on this history page in the form of shape, designation, land area, building area and location details such as maps, longitude, latitude points.

- **System Implementation**

  The next stage is the system implementation stage, which is a continuation of the system design stage, namely translating the system design into a form that can be implemented, namely building a system that has been designed and applying a prediction calculation model to it. The system implementation process involves developing an information system to predict property price data in Surabaya, which is then applied to the system. This system development is done usinLaravel and flask for API.

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- **System Testing**

  System testing focuses on the software in terms of logic and functionality to ensure that all parts have been tested. This is done to minimise errors and ensure that the resulting output is as desired. In this study, system testing was carried out using black-box testing techniques. Black-box testing is a software testing method that is carried out without paying attention to the internal details of the software. In the black-box testing process, the programme is tested by trying to input data on each form. This test is to find out the programme runs as needed.

RESULTS AND DISCUSSION

The initial step of model development is data collection, which is obtained from a database on the Radata website platform. The data taken consists of property data in Surabaya in the range of years 2019 - 2024 with 21 features and 1,990 rows of data. Next,

namely by doing Data Preparation which contains the stages of Data Cleaning, combined data and Data Encoder.

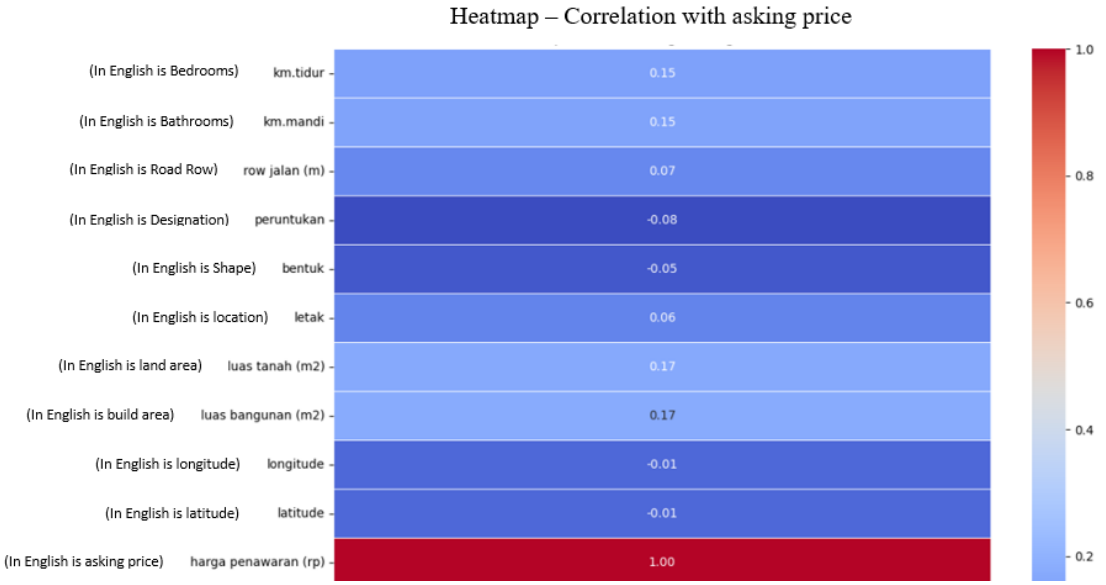

Fig. 7. Heatmap Correlation features

The Figure 6 diagram is a heatmap that shows the correlation between various property features and the asking price (harga penawaran in Indonesian). Correlation measures the relationship between two variables, with values ranging from -1 to 1. Here's how to read the diagram:

a. **Color Scale**:
Dark red (1.0): Very strong positive correlation, dark blue (-1.0): Very strong negative correlation, and lighter colors indicate weaker correlations, either positive or negative.

b. **Correlation Values**:
- **Positive Correlation**: Positive values (e.g., 0.17) indicate that as the feature value increases, the asking price tends to increase.
- **Negative Correlation**: Negative values (e.g., -0.08) indicate that as the feature value increases, the asking price tends to decrease.
- **Zero Correlation**: Values close to 0 (e.g., -0.01) indicate no clear linear relationship between the feature and the asking price.

c. **Interpretation of Each Feature**:
- **km.tidur (bedrooms)**: Positive correlation of 0.15, indicating that more bedrooms tend to increase the asking price.
- **km.mandi (bathrooms)**: Positive correlation of 0.15, indicating that more bathrooms tend to increase the asking price.
- **row jalan (road width in meters)**: Positive correlation of 0.07, showing a weak but positive relationship with the asking price.
- **peruntukan (designation)**: Negative correlation of -0.08, indicating that certain land uses tend to decrease the asking price.
- **bentuk (shape)**: Negative correlation of -0.05, showing a weak but negative relationship with the asking price.

- **letak (location)**: Positive correlation of 0.06, showing a weak but positive relationship with the asking price.
- **luas tanah (land area in m2)**: Positive correlation of 0.17, indicating that larger land areas tend to increase the asking price.
- **luas bangunan (building area in m2)**: Positive correlation of 0.17, indicating that larger building areas tend to increase the asking price.
- **longitude**: Negative correlation of -0.01, showing a very weak and negative relationship with the asking price.
- **latitude**: Negative correlation of -0.01, showing a very weak and negative relationship with the asking price.
- **harga penawaran (asking price)**: Correlation of 1.00, as this is the target variable compared with itself.

The next step is model development, in this step X and Y data will be defined, then divide the amount of data into 2, namely for Test and Train. Next, data training is carried out by implementing the Random Forest method, then using the Hyperparameter Optimization algorithm GridSearchCV method. In the modeling that has been made, the accuracy results will be obtained as in Figure 7 in the form of R2, MAE, and RMSE values.

```
R-squared (R2): 0.8367700789342328
Mean Absolute Error (MAE): 1512363644.942205
Root Mean Squared Error (RMSE): 3563481006.742458
```

Fig. 8. Result of R2 score, MAE, RMSE

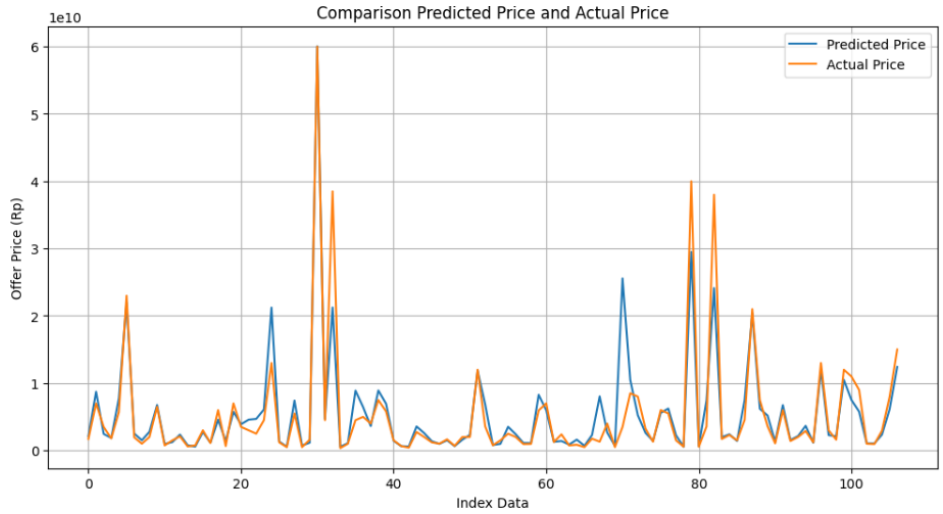

Fig. 9. Comparison of Predict Price and Actual Price

The figure 8 above shows a comparison chart between the predicted price (labelled "Predicted Price" and the blue line) and the actual price (labelled "Actual Price" and the orange line). The X-axis represents the order of the data by index. Each point on this axis indicates a specific time sequence or event of the tested data. The Y-axis shows the offer price value in rupiah (Rp). The numbers on the Y-axis indicate the magnitude of the price at a particular time or index. At some points, especially around indices 20, 40, and 80, there are large spikes in the actual price that are not always well followed by the predicted price, suggesting the model had difficulty predicting these spikes. In contrast,

at many other points, the predicted prices are quite close to the actual prices, suggesting the model works well with the data.

CONCLUSION

After the results of the stages of problem analysis, model development, web development, and system testing on the Development of a Property Value Prediction System in Surabaya Using the Web-Based Random Forest Method, a conclusion is obtained, among others: The implementation of the Random Forest algorithm to predict property values in Surabaya has been successfully carried out. Through the use of this algorithm, the system can analyse property data and produce fairly accurate predictions. The algorithm implementation steps involve data collection, data processing, model training, and testing. The model testing can be proven through the R2 Score evaluation results by showing the accuracy obtained by 83%. This shows that the amount of bid price prediction results can be influenced by the value of each feature such as location (longitude and latitude), road row, property formation, designation, number of bedrooms and bathrooms, and also the land and building area of the property. Web-based applications developed using the Laravel framework have been successfully implemented. This application produces output in the form of property value predictions that can be accessed and used by property appraisers. This can provide value recommendations and make it easier for users to determine the value or price of property in Surabaya.

ACKNOWLEDGEMENTS

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Smart Bed Design in Assisting Routine Control of Patient Health

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Keywords:
Heart rate
Temperature sensor MLX90614
Pulse sensor MAX30100
Smart Bed
Body Temperature

ABSTRACT

Recently, healthcare institutions have started using robots and various sensors to improve service quality and work efficiency. There is no mattress or bed that can automatically control its patients regularly by monitoring pulse, temperature in one system. Can help care for patients who are experiencing hospitalization with the Smart Bed control. This Smart Bed will help health workers to monitor the condition, especially the patient's vital signs, and the results will be obtained in real time so that patients can be treated optimally. The MLX90614 sensor test results show an average error of 1.35% for the first person's body temperature (35.02 °C), 2.42% for the second person (34.56 °C), and 2.16% for the third person (35.24 °C). The MAX30100 sensor had an average error of 3.45% for the first person's pulse rate (81.2 bpm), 3.65% for the second person (82.4 bpm), and 4.08% for the third person (86.4 bpm). The MLX901614 temperature sensor had an average error of 0.37% when compared to the thermogun, showing an accuracy of about 99.63%. While the MAX30100 pulse sensor, compared to a pulse oximeter, has an average error of 1.82%, with an accuracy rate of about 98.18%. So it can be concluded that the smart bed is in the working order.

INTRODUCTION

Introduction Patient mobilization is essential for treatment, requiring patients to be turned every 2 hours with assistance. However, due to mobility challenges and pain for nurses, this is seldom done. An affordable, automatic device for real-time remote patient monitoring is needed. Nowadays, Healthcare institutions are now using robots and sensors to enhance service quality and efficiency. Devices include manual robots for mobilization, tools for moving patients, and automated beds that adjust bed sheets. In addition, many beds have been developed such as air mattresses, alternating pressure mattresses, and side-rotating mattresses to prevent pressure sores(TaryTaryudi, T., Lindayani, L., & Darmawati, I. (2022). Smart-bed with Internet of Things for Pressure Ulcer. . However, it is still energy-intensive and time-consuming. No mattress or bed can automatically monitor patients' pulse and temperature in one system, and they still rely on batteries instead of a direct power supply(Muhammad et al., 2021). Can help care for patients who are experiencing hospitalization with the Smart Bed controller. This Smart Hospital Bed will help health workers to monitor the situation, especially the patient's vital signs(Goyena, 2021). So for the smart bed made this time there are differences in terms of sources that are more efficient and the tool can be moved anywhere.

RESEARCH METHOD

In this chapter there will be several stages such as depicting the research flowchart and the flowchart of the tool's work system, designing software and hardware, designing the components to be used, and designing the wiring in the tool.

1.1. Research Steps

In determining the research that will be used in making this Smart Bed, there will be several stages that will be carried out which are contained in Figure 1 in the form of the following flowchart.

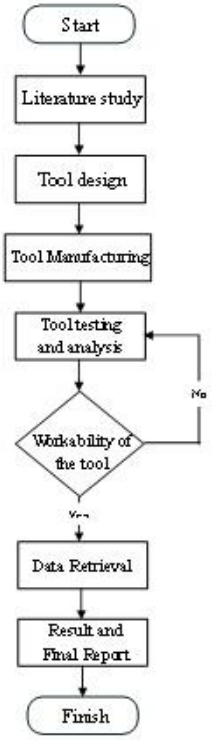

Figure 1. Research Flow Chart
Source : personal documents

The following is an explanation of the research diagram as follows:

1. Conduct a literature review of recent journals and articles..
2. After gathering references, we will design the tool, determining the hardware and software before proceeding further.
3. Build and adjust the tool as needed.
4. After the tool functions correctly, we will collect data from the tests.
5. Summarize the results and data analysis in the final report.

1.2. Create Tool Planning Schematics

This stage determines the flow rate of the components used. The following figure 2 in the planning of the tool lane scheme at the tool scheme planning stage:

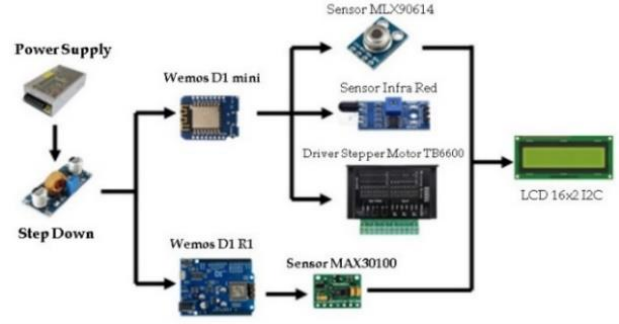

Figure 2. Tool Planning Scheme

Source : personal documents

In this scheme, a power supply will provide power to the Arduino, which is connected to three sensors (MLX90614, MAX30100, infrared), an LCD, and a stepper motor(Iqbal et al., 2020)with a motor driver as a motor controller using a step down to reduce the DC voltage from the power supply.

1.3. Tools Work

To create a tool, we will start by setting a starting point and defining the maximum limits for each sensor. After programming these into the tool, someone will lie down to measure their body temperature and pulse rate. The person places their finger on the pulse sensor, and the infrared sensor detects their hand, activating the stepper motor to measure body temperature. The results are sent to MQTT and displayed on an LCD, and a notification with the measurements will appear on a mobile phone, completing the process.

1.4. Schematic of Microcontroller Design

In designing the tool circuit, a power supply will be used as a source. The choice of power supply is that it can be useful in 24 hours because it can be connected to a power source directly. The following are components in the circuit that will be used such as Wemos D1 R1(Suhermanto & Aribowo, 2023), Wemos D1 Mini(Abrianto & Sari, 2021), MLX90614 temperature sensor(Alam et al., 2022), MAX30100 Pulse Sensor(Rahmawarni & Harmadi, 2021)(Aditya & Riska, 2020), and Infra Red Sensor (Suryana, 2021)seen in Figure 3.

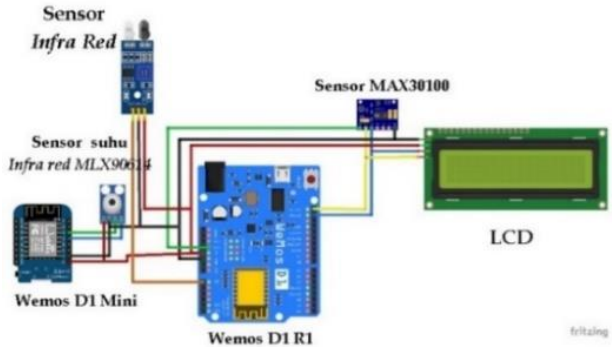

Figure 3. Microcontroller Circuit Schematic
Source : personal documents

RESULTS AND DISCUSSION

Researc This research test aims to determine and analyze the value of a person's pulse and body temperature in the sensor value and the conventional tool value. In this research, it is intended to be used more flexibly which can be used to the bed that requires it.

1.5. Tool Design Results

Figure 4 of the smart bed prototype hardware results shows the use of angle iron (0.1 mm thick, cut to 46 cm x 57 cm), plywood (0.3 mm thick, cut to 40 cm x 46 cm), and PVC foam board (0.1 mm thick). A 3D design draft was created and adjusted using Sketch Up.

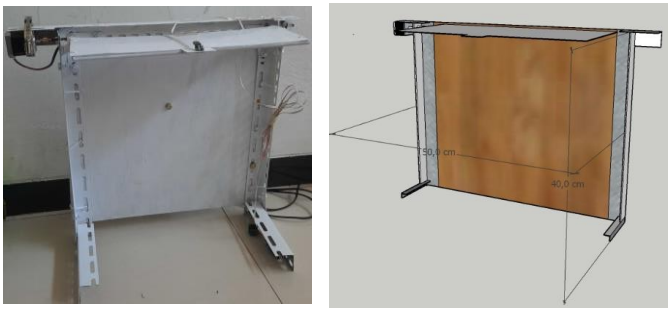

Figure 4. Realization of smart bed design
Source : personal documents

1.6. Software Design Results

In this section, the results of creating a program to MQTT are made through the Arduino IDE software. MQTT is an efficient and structured communication protocol between connected devices and systems(D. A. Awwal et al., 2023). The program that has been uploaded will read the sensor, namely the MLX90614 sensor, which reads the status of hyperthermia, normal and hypothermia(Cahyadi et al., 2021) while the MAX30100 sensor reads the pulse status, namely bradycardia, normal and tachycardia(Akbar et al., 2018) (Setiarini et al., 2021)(Prayogo et al., 2017)MQTT display in Figure 5.

Figure 5. Measurement view on MQTT
Source : personal documents

1.7. Testing the difference in value of MLX90614 Infra Red Temperature Sensor and Thermogun

This test aims to determine the level of accuracy of the tool when implemented in real circumstances. Based on the tests that have been carried out, the measurement results obtained have been measured using the MLX90614 Infra Red sensor and thermogun.

Table 1. Testing temperature measurement in the 1st person

No	Experiment	MLX90614 Sensor (°C)	*Thermogun* (°C)	Difference (°C)	Precentage *Error* (%)
1	First	35,3	35,4	0,1	0,28

No	Experiment	MLX90614 Sensor (°C)	*Thermogun* (°C)	Difference (°C)	Precentage *Error* (%)
2	Second	35,2	35,3	0,1	0,28
3	Third	34,6	34,8	0,2	0,57
4	Fourth	35,2	35,3	0,1	0,28
5	Fifth	34,8	34,9	0,1	0,29
Average measurement error					0,34

Source : personal documents

1.8. Testing the difference between the value of the MAX30100 Pulse Sensor and the Pulse Oximeter

In this next test, it aims to determine the level of accuracy of the tool on the sensor used when implemented in actual circumstances. Based on the test results that have been carried out and shown in table 2, the measurement results obtained using the Pulse Rate MAX30100 sensor and Pulse Oximeter.

Table 2. Testing the Pulse Rate measurement of the 1st person

No	Experiment	MAX30100 Sensor (bpm)	Pulse Oximeter (bpm)	Difference (bpm)	Precentage *Error* (%)
1	First	85	83	2	2,41
2	Second	83	82	1	1,21
3	Third	84	81	3	3,70
4	Fourth	82	82	0	0
5	Fifth	81	83	2	2,41
Average measurement error					1,94

Source : personal documents

1.9. Discussion in the form of graphs

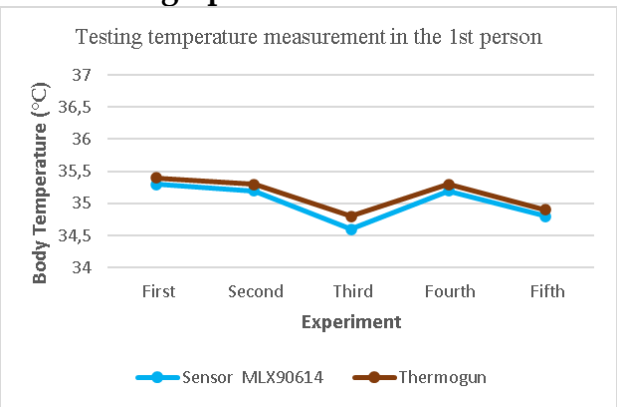

Figure 6. Graph of temperature measurement values of MLX90614 and Thermogun in 1st person

Source : personal documents

Figure 6 shows that the measurement results from the MLX90614 sensor obtained an average of 35.02°C. From the graph of the temperature measurement difference between the MLX90614 sensor and the thermogun, it can be seen that the majority of the differences are in the range of 0.1 to 0.2 degrees Celsius. Overall, this graph shows that the MLX90614 sensor has a stable and consistent performance in body temperature measurement compared to the thermogun.

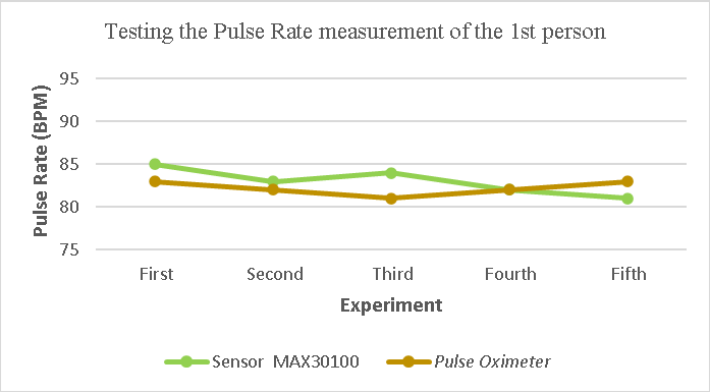

Figure 7. Graph of temperature measurement values of MAX30100 and Pulse Oximeter in the 1st person
Source : personal documents

In figure 7, it can be seen that the average pulse rate measured using the MAX30100 sensor which is about 83 bpm is slightly higher than that measured using the pulse oximeter which is 82.2 bpm. However, the difference is not very significant in the example data given.

CONCLUSION

Based on the results of research on the research title of the smart bed design tool in helping routine control of patient health, conclusions can be drawn, namely:

1. From the test results of the MLX90614 infrared contactless temperature sensor by comparing the results with measurements using a thermogun, the test results show that the MLX90614 sensor has an accuracy rate of 99.63%. This means the average measurement error rate is only 0.37%.
2. From the test results on the MAX30100 pulse sensor by comparing the measurement value of the pulse reading in bpm on the pulse oximeter, the test results and data collection concluded that the MAX30100 pulse sensor has an average measurement error of 1.82%. Therefore, the accuracy of the sensor can be considered as 98.18%.

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Design of Solar Panel Utilization as a Mobile Phone Charger Station Box in Online Ojek Places

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Keywords:
Arduino Uno
Battery VRLA
Battery station handphone
Radio frequency identification (RFID)
Photovoltaic
Solenoid door lock

ABSTRACT

One of the problems in the field of electrical energy is the limited source of coal energy which is the main source of energy from steam power plants in Indonesia. To reduce electricity dependence on this limited coal, a renewable energy source is needed. Solar panels are one of the producers of electrical energy sourced from sunlight that always shines and does not cause pollution. The use of solar panels is the best solution for current conditions as an alternative energy source to be utilized as a source of cellphone battery charging at online motorcycle taxi stations. This final project aims to design, manufacture and install a solar power plant as the main source on the handphone charger station box at the online motorcycle taxi place. The SOLAR POWER installation consists of 1 100 WP solar panel, 1 10A SCC, 1 12V 65Ah battery, 1 600W inverter, AC and DC MCBs, cables, power outlets, Arduino uno, relays, LCD, RFID, solenoid door lock.

INTRODUCTION

The development of technology is currently growing rapidly, especially in the field of electrical energy sources, where energy sources can be obtained from steam, gas, nuclear and geothermal power plants (Budianto, 2016; Meliala et al., n.d.; Mulyadi et al., 2023). These sources of electrical energy are non-renewable sources of electrical energy and the cost to operate them is very expensive. The growth of electrical energy and the rising price of fossil fuels trigger research on increasing the efficiency of renewable energy, especially on solar energy. In utilizing solar energy, it is necessary to develop a tool that is able to convert solar energy into electrical energy, this tool is usually referred to as a solar panel or collar cell. Electric energy consumption is increasingly needed, due to the rapid development of technology with a lot of sophistication that makes humans increasingly dependent on electronic devices, especially on cell phones in supporting daily work. Busyness with activities and high mobility has indeed become the lifestyle of some people. Cellphones obviously need a battery that functions as an energy source on the cellphone(Prayogo, 2019) (Awasthi et al., 2020; Charfi et al., 2018; Mursidan et al., n.d.). But it is unfortunate if the activities carried out outside the room must be hampered by the condition of the battery energy that runs out quickly, then we need to fill it up so we can use it again. Another obstacle that often occurs when the cellphone battery runs out is that when carrying a cellphone charger we don't easily find a source of electrical

energy even though the energy source exists we feel uncomfortable charging the battery at a battery charging place in an unknown person's place.

Some research has been done to make battery charging by utilizing solar energy sources such as the Implementation Charger HP dengan panel surya, sistem Pembangkit listrik tenaga surya (SOLAR POWER) untuk *Charger* laptop dan HP di IST AKPRIND YOGYAKARTA(Budianto, 2016). Therefore, a practical and safe tool is needed in charging batteries that utilize solar energy sources. Based on the above background, the author took the final project with the title "Design of Utilizing Solar Panels as a Mobile Charger Station Box at Online Ojek Places". Which one day is expected to be used in various public facilities.

RESEARCH METHOD

This research is an experimental research. It is necessary to design and manufacture a solar power generation device as a service for providing electricity to the cellphone charger station box at the online motorcycle taxi place. Data collection in this study was carried out by observing the test equipment to determine whether the equipment used functions as designed and obtaining measurement data from each component used. Furthermore, analyze the experimental data as quantitative data by reviewing and displaying in tabular form. Furthermore, presenting the information obtained in the form of text that is easy to understand and basically aims to provide answers to the research questions studied.

1.1. Syestem Planning

At this stage determine several components and calculate the needs of the components that will be needed. The following are the steps that must be taken when designing a solar power system.

In calculating the number of watts of power that will used for charging the hanphone battery that will be supplied by the solar panel. by the solar panel. Discharging power can be calculated by using equation 1(Cahyono et al., n.d.; Jamaaluddin, 2021; Rizaldi et al., n.d.):

$$Wh = P \times h \quad (1)$$

Description:
Wh = Discharging power
P = Load power in use
H = Usage time

Daily load that will be supported by solar panels. Charger handphone charger with a maximum power of 15W amounted to 3 pieces with an estimated usage of 8 hours, one lamp with a power of 5W totaling 1 with an estimated 12 hours of use. So in get a power requirement of 420W

Calculate how many solar panels are needed will be used on the handphone Charger station box tool. Can calculated by equation 2(Suduri et al., 2021):

$$Wp\ Solar\ panel = Wh \div 5 \quad (2)$$

Description:
Wp = Total energy
5 = Optimal solar time
Then the solar panel that will be needed in this research olar panels with a capacity of $Wp\ Solar\ panel = 420 \div 5$100Wp.

Determining battery capacity must take into account the battery efficiency and when using the battery should not be used until all the power in the battery runs out. Battery capacity the ideal battery capacity is 1,5 times the battery requirement Determining the battery needs can use equation 3(Suduri et al., 2021):

$$Ah = \frac{1{,}5 \times Wh}{V} \quad (3)$$

Description:
Ah = Battery Capacity
Wh = Discharging power
V = Voltage on the battery
So the battery capacity used in this study that is with a capacity of $Ah = \frac{1,4 \times 420}{12}$ = 52.5Ah, then a 70 Ah battery is used which is common in the market

In determining the capacity of the SSC, you must first know the characteristics and specifications of the solar panel in order to know the needs of the solar charger controller, on the solar panel. there are the following specifications:

Pm = 100Wp
Vm = 17,8V DC
Imp = 5,62A
Vcc =21,8V
Isc =6,0A
After knowing the specifications and characteristics of solar panels, the capacity of the solar charger controller can be calculated using equation 4(Suduri et al., 2021).

$$ISCC = Isc\ Panel\ \times Total\ Panel \quad (4)$$

Description:
ISCC = Current capacity of the SCC
Isc Paanel = Current on solar panel
Current capacity on SCC $ISCC = 6{,}0 \times 1 = 6A$. So that the SCC used is at least 6 A and in this research used an SCC of 10 A.
Determining the inverter that will be needed in this study can be used equation 5(Suduri et al., 2021) (Book, 2019; Julisman et al., 2017; Mulyadi et al., 2023; Ramadhan et al., n.d.):

$$Capacity\ Inverter = Demend\ Wh\ \times 1{,}25 \quad (5)$$

Description:
Demand Wh = Required load power
1.25 = Safety factor
So the inverter requirement in this research is $420\ x\ 1{,}25 = 525W$, so an inverter of 600Watt is used.

1.2. Solar and Microcontroller System Diagram

The design of the solar panel System in this study was carried outwiring in the circuit according to the design diagram so that the components used can run well (Gunoto & Sofyan, n.d.). The following is aschematic drawing of the design solar power seen in Figure 1:

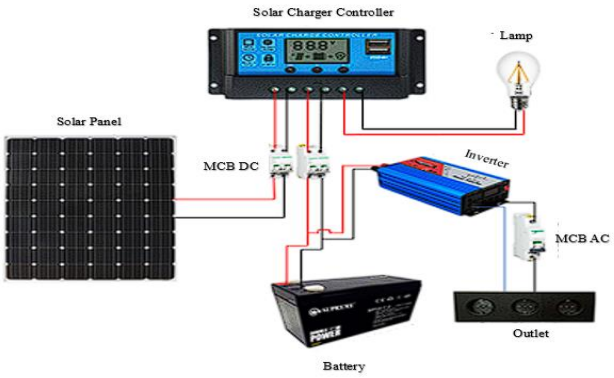

Figure 1. Solar Panel System
Source: Personal Documents

In the cellphone battery charging box security has several electronic components, namely RFID this circuit serves to identify the card that will be used for security on the box, LCD serves as to display data in character form, solenoid door serves to lock the door by using electrical voltage. The following is a table of tools and materials required.

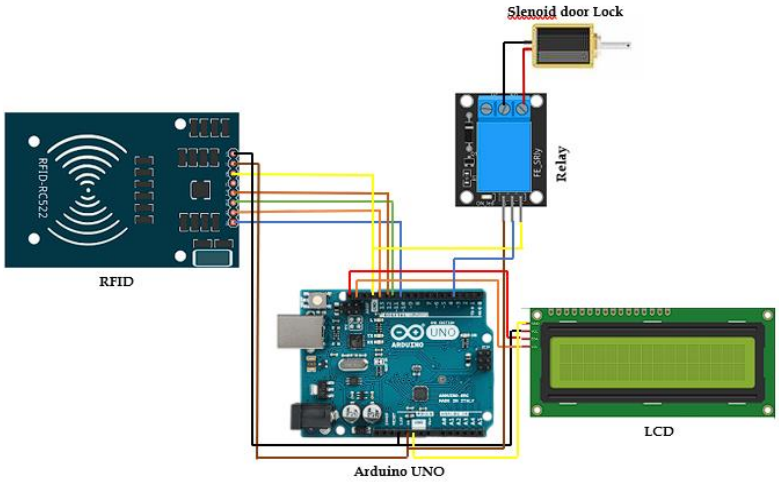

Figure 1. Microcontroller circuit on battery charging box

Source: Personal Documents

RESULTS AND DISCUSSION

This research test aims to determine and calculate the voltage, current and power generated in the solar panel component. In addition, it is also to determine the performance of the components used for locking the locker. In this research, sunlight acts as an alternative energy so that the use of conventional electrical energy can be minimized by switching to new and renewable energy through the use of solar panel.

1.3. Tool Testing

Testing solar panels with a capacity of 100WP to convert sunlight into direct current (DC) electrical energy. The testing process was carried out for 5 days starting from 08.00 WIB until it ended at 15.00 WIB·

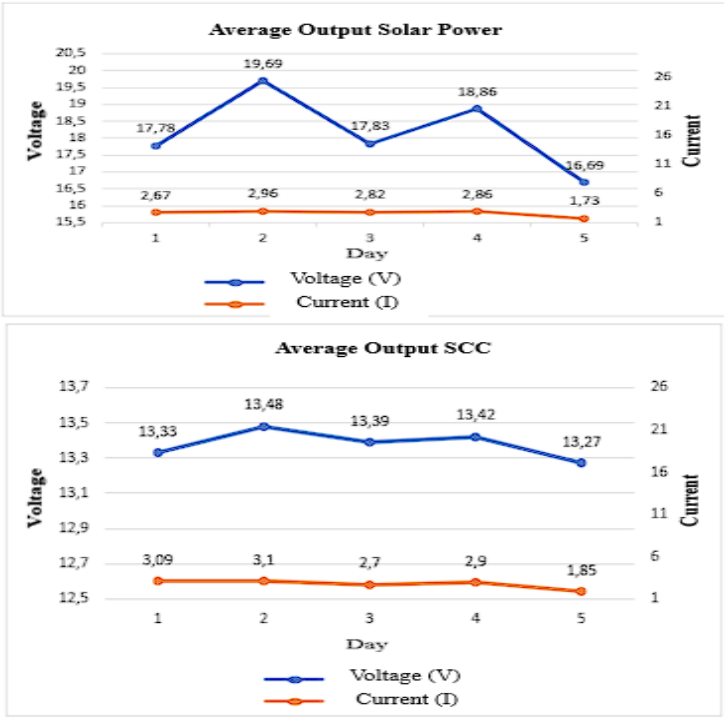

Figure 3. Average output of polar panel and charger controller in 5 days.
Source: Personal Documents

From the test data of the solar panel output and the solar charger controller output, it can be seen that the average voltage of the solar panel output is around 16.69 V - 19.69 V. But the average output of the solar charger controller is more stable, which is around 13.27-13.48 V. This situation is almost the same every hour. This happens because in the solar charger controller there are series to regulate the voltage and current therefore the battery charger when charging every hour will always be stable. The work process of solar panels is highly dependent on brightness conditions. If the solar panel gets bright sunlight, the voltage and current obtained will be large, on the contrary, if the weather is cloudy or the solar panel does not get bright sunlight, the voltage and current obtained decrease. As in Figure 3 where the voltage generated by the solar panel is the largest, namely 19.69V and a current of 2.96A. This is the

highest average generated by solar panels in a day, but this is certainly different weather every day and greatly affects the power generated every day.

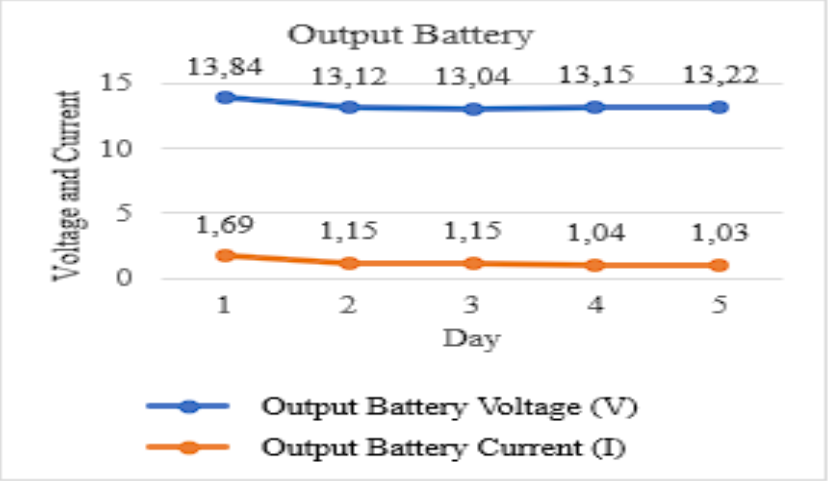

Figure 4. Average output of battery in 5 days.
Source: Personal Documents

IIn this test, it was carried out for 5 days and the battery output results were obtained with an average voltage and current value that fluctuated in 5 days of research as shown in Figure 4. This is due to the input voltage when charging is not maximized due to weather. Although the average battery voltage output is not stable, the battery is still able to meet the load requirements. The load used is a cellphone with a charging criteria of 15 watts.

From the average results of inverter testing can be seen in Figure 5. The figure shows the results of the inverter output for 5 days with a value of 221.44V - 218.9 V. for the resulting current has an average value of 0.11 A - 0.18 A·

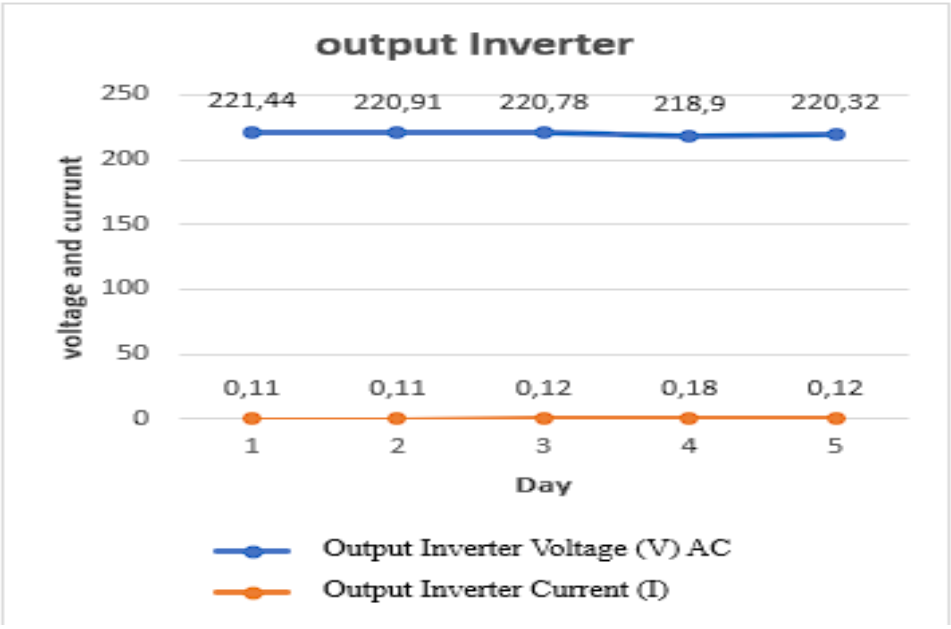

Figure 5. Average output of inverter in 5 days.
Source: Personal Documents

1.4. Sensor Test

Table 1. Sensor testing

NO	Time	Day	RFID Test		Solenoid Test	
			Successful	**Unsuccessful**	**Open**	**Close**
1	11.00	1	Successful	-	Open	-
2	13.00	1	Successful	-	Open	-
3	13.00	2	Successful	-	Open	-
4	15.00	2	Successful	-	Open	-
5	10.00	3	Successful	-	Open	-
6	13.00	3	Successful	-	Open	-
7	09.00	4	Successful	-	Open	-
8	11.00	4	Successful	-	Open	-
9	13.00	5	Successful	-	Open	-
10	15.00	5	Successful	-	Open	-

Source: Personal Documents

Table 1. Rfid is tested to determine the success rate of the rfid sensor against the card. Solenoid testing aims to determine the performance of the solenoid open / not open.test results of security on rfid and solenoid contained in the battery drain box as a safety box. Rfid is tested to determine the success rate of the rfid sensor against the card. Solenoid testing aims to determine the performance of the solenoid open / not open. For the percentage of success of the work of the cellphone battery charging box security system is 100% for the functioning of the doorlock solenoid, and 100% for the functioning of the RFID sensor. For cards that are in use that can use E-toll cards as a lock.

CONCLUSION

1. In this final project, the total load power required is 420 Wh, so that the capacity of each component unit is obtained, namely 1 unit of 100 WP solar panels, 1 unit of 10A SCC, 1 unit of 12 V 65 Ah battery, and 1 unit of 600 W inverter.
2. The highest average voltage, current, power obtained by solar panels occurred on day 2 of 19.69 V with a current of 2.96 A, the highest average power obtained by the inverter occurred on day 2 of 220.91 watts, and the lowest average voltage, current, power on solar panels is 16.69 V and 1.73 A occurred on day 5, the lowest average power obtained by the inverter occurred on day 5 of 220.32 Watts. The intensity of sunlight shining on solar panels affects the amount of voltage and current for charging batteries using loads.

3. For the percentage of success of the work of the cellphone battery charging box security system is 100% for the functioning of the doorlock solenoid, and 100% for the functioning of the RFID sensor.

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Development Of A Media Training Model ZETRAS (Zenkutsudachi Training Speed) To Increase The Speed Of Forward Stance In The Sport Of Karate

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Keywords:
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ABSTRACT

The research aims to develop training aids to increase the speed of the heavy front stance in karate hich can be called ZETRAS (Zenkutsudachi Training Speed). The method used in this research is R&D (Research and Development) using the fice-stage method, namely ADDIE. The population in this study were Inkanas Banyuwangi karate athletes with a sample of 35 athelets. The results of pretest dan posttest data analysis obtained sig= 0.000 < 0.0,5, while the results of the questionnaire on comfort of using the equipment were 57.1% "AGREE" and 37.1% "Strongly AGREE". Based on the results of the research above, it can be concluded that there is an influence of training to increase the speed of the heavy front karate stance and it has proven to be comfortable for Inkanas Banyuwangi karate athletes to use.

INTRODUCTION

Karate is a sport that requires players to have good physical, technical, tactical and mental conditions (Hardiansyah et al., 2022) . In The sport of karate has basic techniques that are mandatory mastered These are : stance technique (dachi), parry technique (uke), punch technique (tsuke), and kick (geri) (JB Sujoto, nd) . Aspect condition physique very important noticed remember Power endurance , speed , strength , agility , power and balance . Condition physique Alone is components that are important and those that are not Can ignored by everyone athlete For reach pretation the highest (Cahyadi, 2019) . Every athlete own condition different physiques , then from That must carry out an existing exercise program made by the trainer (Wulansari, 2018) . Condition physique This is something components that cannot simply be separated in improving maintenance. Condition physical requirements at the branch the dominant sport of karate is Power endurance , speed , strength , agility , power and balance (Irwansyah et al., 2022) .

Good training is training that has many variations of training models, therefore the task of a physical trainer or technical trainer is to create a training program that is as interesting as possible to create a pleasant situation. (Budi, 2021) . Exercise should be

done 3x a week, because after 48 hours Power stand someone will decline , training 4x per week has better results, training 5x per week has better results than 4x per week, maximum exercise 6x per week for specific goals while training every day per week is not recommended because it is not enough for recovery time, thus causing easy illness or injury (Aldapit, 2019) .

In observations made by researchers , he found problems experienced a karate athlete when in the field . Movement the front heavy stance technique is slow, this is because the trainer focuses the training only on punches and kicks. Meanwhile, technical horses are rarely trained specifically. The solution will be given is practice speed sawhorse heavy front karate use modification of used tires . Objective from Speed training sawhorse heavy front using used tires For give enhancement physique component biomotor speed and stance technique heavy front . Speed ability somebody in do movement continuous with the same shape in time in short (Mansur, Saifuddin, 2015) .

Technique zenkutsudachi that is sawhorse front that way do it with zig-zags and the shape is zig-zag, isn't it? One line (Rozi, 2021) . Loading body weight (centre style weight) on the horses This more less than 60% on the front legs , 40% on the back legs (Santi Septiyani et al., 2005) . Practice karate stances very well necessary and focused Because coordination between kicks and punches very required when perform complete karate movements .

Development is method research used For research so that produce product new and continued with test its effectiveness For know appropriateness from developed products (Sugiyono, 2016) . Development of a used tire media practice model This called ZETRAS (Zenkutsudachi Speed Training). With created it *zetras* so athlete become more enthusiastic and able give maximum result in accordance with training goals . Exercise based media *zetras can be implemented as an exercise to increase the speed of the* front heavy stance karate sport. This exercise just focused on speed, because when the heavy front stance technique is not in sync with the speed of punching and kicking techniques, there is a lack of coordination between the combined techniques. the.

Practice is necessary exists enhancement performance athlete For get maximum training results . Peak performance athlete is something circumstances Where mind and muscle Work the same , both mentally and physical , so appearance athlete can increase ability normally (Lestari & Dewi, 2022) . When athletes own good performance so No close possibility in match achieving achievement targets . Performance Can achieved if fulfil a number of component such as : athletes potential , next coached and directed by a coach , for give a trial with do competition and try outs are good domestically or abroad with objective measure ability competing / competing and maturity as technical, physical and mental formation of competition (Handayani, 2019) .

Based on problems found in the field so in effort increase speed sawhorse heavy front on karate athletes , writer interested For do study Development of the ZETRAS (Zenkutsudachi Speed Training) Media Training Model for Increase Speed Sawhorse Heavy Front Karate sport . Through the Zetras media speed training model expected can help internal karate athlete increase speed with more optimal. And can used and useful for coaches and many people as guidelines in do speed training .

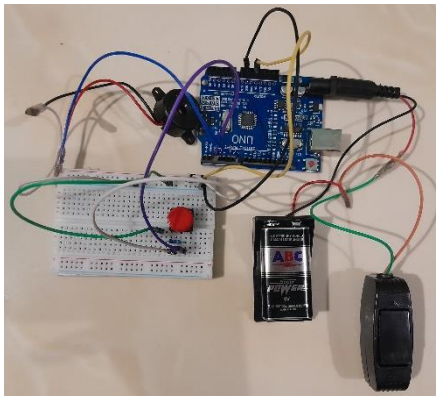
RESEARCH METHOD

Type research used in research This is study development of Research and Development, research activities are carried out For look for information about problems and needs users , while development is carried out For produce device as solution (Nusa Putra, 2015) . Stages in Research and Development in study in a way operational take ADDIE method consisting from : 1) Analysis, 2) Design , 3) Development, 4) Implementation, 5) Evaluation (Cahyadi, 2019) . Place study held at the Inkanas Karate Dojo Banyuwangi , Kab . Banyuwangi with time study One month . Population Inkanas karate athlete Banyuwangi with sample of 35 athletes aged 13-18 years . Data collection techniques use test measurement with method pretst and posttest and data collection instruments using test component 20m sprint physical . The data analysis technique uses the T Test with SPSS analysis and questionnaires were analyzed in a way descriptive .

RESULTS AND DISCUSSION

Results on research This that is Development of the ZETRAS (Zenkutsudachi Speed Training) training model for increase speed sawhorse heavy front karate sport . Exercises that use instructions in a way automatic without instructions from trainer who makes it easy athlete along with coach For sawhorse heavy front of karate. The ZETRAS tool is also available book guide with title " Guidebook for Using the ZETRAS Zenkutsudachi Speed Training Improving Tool Speed Sawhorse Heavy Home Karate" to get it makes it easier user in operate tool the .

Material main used namely used tires , catheters and ankle straps, assisted with tool electronic supporter namely software, Arduino Uno, beard board, jumper cables , push button, resistor, buzzer, battery , battery holder and switch . tool electronic assembled in accordance support needs achieved tool zetras the one that can emit voice or as instructions automatic . The sound emitted Already programmed in the software with Instructions: 3 sets, 8 reps with a 10 second rest . Pause each set is different , p This aim For readiness athlete without must guess repetitions one and so on . When the circuit electronic Already So so attached to the part side in used tires . How to use it Enough push knob switch as on/off Then pressing the colored push button red so tool zetras Ready used .



Picture 1. Electronic circuit
Source : researcher

Picture 2. Zetras tool circuit
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Table 1. Normality Test

	Kolmogorov-Smirnov [a]			Shapiro- Wilk		
	Statistics	df	Sig.	Statistics	df	Sig.
PRETEST	.071	35	,200 *	,971	35	,466
POSTTEST	.117	35	,200 *	,965	35	,324

Kolmogorov-Smirnov [a]	Shapiro- Wilk	Kolmogorov-Smirnov [a]	**Shapiro - Wilk**	Kolmogorov-Smirnov [a]	Shapiro- Wilk
Statistics	df	Statistics	df	Statistics	df
PRETEST .071		PRETEST	.071	PRETEST	.071
POSTTEST .117					

Normality test Shapiro Wilk carried out on pretest and posttest speed data easel , and produce mark significance each of 0.466 and 0.324. With use level alpha significance of 0.05, second mark the show that No there is Enough proof For reject hypothesis zero , that the data is distributed normally . Therefore that , second pretest and posttest samples can be considered normally distributed at level significance >0.05.

Table 2. Descriptive Statistics Paired Sample t-test

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	PRETEST	4.6554	35	.35251	.05958
	POSTTEST	4.3726	35	.35052	.05925

Table 3. Paired Samples Test

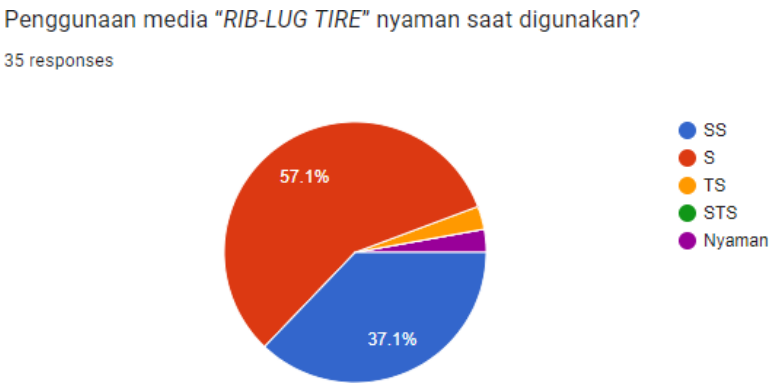
	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation n	Std. Error Mean	95% Confidence Intervals of the Difference Lower	Upper			
Pair 1 PRETEST - POSTTEST	.2828 6	.20897	.03532	.21107	.35464	8,008	34	,000

Table 4. Summary of T Test Results

	Mean	*t-test for equality of means*			
		t	df	Sig. (2 *tailed*)	*Mean difference*
Pre- test	4.6554	8,008	34	0,000	4.6

Based on the output table of t test results, the value obtained is sig = 0.000 < 0.05. Thus, H 0 is rejected and Ha is accepted. Then, based on the results of the descriptive analysis, the pretest mean value was obtained amounted to 4.6554 and on the posttest amounting to 2.3726. This means that there was an increase in the speed of the front heavy stance after receiving speed training in the front heavy stance using Zetras development media.

Diagram 1. Questionnaire Results



The results of the comfort questionnaire for using tools given to Inkanas Banyuwangi karate athletes showed 57.1% "AGREE" and 37.1% " STRONGLY AGREE ". It is proven that there is comfort in using the Zetras tool.

Table 5. Minimum Maximum

	Pretest	Posttest
Minimum	4.09	3.66
Maximum	5.20	4.90
Mean	4,658	4,629

Pretest results The research showed a minimum value of 4.09, a maximum value of 5.20, and an average of 4.658. Meanwhile the results posttest shows a minimum value of 3.66, a maximum value of 4.90, and an average of 4.629.

DISCUSSION

Training uses used tires as a medium which aims to make athletes more active in carrying out training, so that Chest pass skills will develop further so it will become better (Main et al., 2021) . Weight training is a great way to improve speed kick sickle, Where process with use n something just a load made as tool For add No only strength but also speed in reach objective (Kasmandana et al., 2019) . Speed refers on movement in do something Skills not only just speed in move. Moving member physique is quickly becoming the most important skill for a sportsman in maximizing his potential and must be improved according to the required sports skill area (Crish & Lodge, 2015) .

Pretest result data and posttest Inkanas Banyuwangi Karate athlete's 20 meter sprint What was obtained was: The hypothesis tested was that there was an increase in speed ability in performing the Zenkutsu Dachi stance or the heavy front stance of Inkanas Banyuwangi Karate athletes. From the results of data analysis, it was obtained that t count (to) = 8.342 with a probability level (P) = 0.00 < α = 0.05), p This means that H_0 is rejected and H_1 is accepted, meaning there is a good influence on increasing the speed ability of the Zenkutsu Dachi stance . or the heavy front stance of Inkanas Banyuwangi Karate athletes after being treated with Zetras modified speed training . Thus, it can be concluded that the Zetras modified media speed training treatment was provided have a significant effect towards improvement front heavy stance speed Inkanas Banyuwangi karate athlete.

Enhancement something ability speed sawhorse zenkutsu dachi or sawhorse heavy front of Inkanas Karate athletes Banyuwangi will succeed with Good if any training elements systematic , structured and measurable . Types of weight training other For increase speed is weight training explosive with burden light (Fossmo & van den Tillaar, 2022) . Speed training This Can added load that is not too heaviness in the legs or arms (Mintarto, 2019) . In study This relevant with framework think that has developed based on supporting theories study This . With thus Speed training sawhorse zenkutsu dachi or sawhorse heavy front using development media zetras there is enhancement ability speed sawhorse zenkutsu dachi or sawhorse heavy front of Inkanas Karate athletes Banyuwangi .

Based on Exercise Which used For increase speed Front heavy stances use Zetras media . When carrying out exercises using assistive devices, the main thing that needs to be

considered is comfort. This indicates that there is a need for knowledge and understanding of the elements comfort in training for athletes and coaches is a necessity (Sutrisna et al., 2018) . With thereby from discussion on Zenkutsu dachi stance speed training or front heavy stance using Zetras development media there is an increase ability speed Zenkutsu Dachi stance or the heavy front stance of Inkanas Banyuwangi Karate athletes. As well as the ZETRAS (Zenkutsudachi Training Speed) modification tool to increase the speed of the front heavy stance for comfort when used for training by athletes .

CONCLUSION

Based on analysis results research and discussion can concluded that use the ZETRAS (Zenkutsudachi Training Speed) tool is effective in increase speed sawhorse heavy front karate athlete. Zetras media training model development tool later can used for all type karate stance. As well as the Zetras media development training model this can developed in components physique strength, due to research this only used for increase speed sawhorse heavy front of karate.

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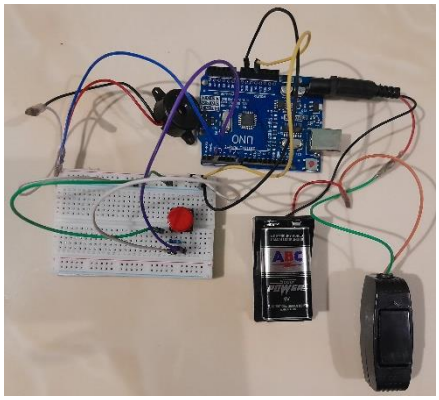

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Statistics	df	Statistics	df	Statistics	df
PRETEST .071		PRETEST	.071	PRETEST	.071
POSTTEST .117					

Normality test Shapiro Wilk carried out on pretest and posttest speed data easel , and produce mark significance each of 0.466 and 0.324. With use level alpha significance of 0.05, second mark the show that No there is Enough proof For reject hypothesis zero , that the data is distributed normally . Therefore that , second pretest and posttest samples can be considered normally distributed at level significance >0.05.

Table 2. Descriptive Statistics Paired Sample t-test

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	PRETEST	4.6554	35	.35251	.05958
	POSTTEST	4.3726	35	.35052	.05925

Table 3. Paired Samples Test

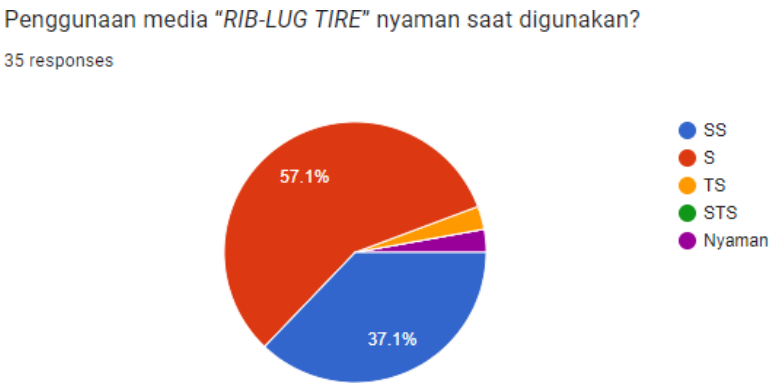
	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation n	Std. Error Mean	95% Confidence Intervals of the Difference Lower	Upper			
Pair 1 PRETEST - POSTTEST	.2828 6	.20897	.03532	.21107	.35464	8,008	34	,000

Table 4. Summary of T Test Results

	Mean	*t-test for equality of means*			
		t	df	Sig. (2 *tailed*)	*Mean difference*
Pre- test	4.6554	8,008	34	0,000	4.6

Based on the output table of t test results, the value obtained is sig = 0.000 < 0.05. Thus, H 0 is rejected and Ha is accepted. Then, based on the results of the descriptive analysis, the pretest mean value was obtained amounted to 4.6554 and on the posttest amounting to 2.3726. This means that there was an increase in the speed of the front heavy stance after receiving speed training in the front heavy stance using Zetras development media.

Diagram 1. Questionnaire Results



The results of the comfort questionnaire for using tools given to Inkanas Banyuwangi karate athletes showed 57.1% "AGREE" and 37.1% " STRONGLY AGREE ". It is proven that there is comfort in using the Zetras tool.

Table 5. Minimum Maximum

	Pretest	Posttest
Minimum	4.09	3.66
Maximum	5.20	4.90
Mean	4,658	4,629

Pretest results The research showed a minimum value of 4.09, a maximum value of 5.20, and an average of 4.658. Meanwhile the results posttest shows a minimum value of 3.66, a maximum value of 4.90, and an average of 4.629.

DISCUSSION

Training uses used tires as a medium which aims to make athletes more active in carrying out training, so that Chest pass skills will develop further so it will become better (Main et al., 2021) . Weight training is a great way to improve speed kick sickle, Where process with use n something just a load made as tool For add No only strength but also speed in reach objective (Kasmandana et al., 2019) . Speed refers on movement in do something Skills not only just speed in move. Moving member physique is quickly becoming the most important skill for a sportsman in maximizing his potential and must be improved according to the required sports skill area (Crish & Lodge, 2015) .

Pretest result data and posttest Inkanas Banyuwangi Karate athlete's 20 meter sprint What was obtained was: The hypothesis tested was that there was an increase in speed ability in performing the Zenkutsu Dachi stance or the heavy front stance of Inkanas Banyuwangi Karate athletes. From the results of data analysis, it was obtained that t count (to) = 8.342 with a probability level (P) = 0.00 < α = 0.05), p This means that H_0 is rejected and H_1 is accepted, meaning there is a good influence on increasing the speed ability of the Zenkutsu Dachi stance . or the heavy front stance of Inkanas Banyuwangi Karate athletes after being treated with Zetras modified speed training . Thus, it can be concluded that the Zetras modified media speed training treatment was provided have a significant effect towards improvement front heavy stance speed Inkanas Banyuwangi karate athlete.

Enhancement something ability speed sawhorse zenkutsu dachi or sawhorse heavy front of Inkanas Karate athletes Banyuwangi will succeed with Good if any training elements systematic , structured and measurable . Types of weight training other For increase speed is weight training explosive with burden light (Fossmo & van den Tillaar, 2022) . Speed training This Can added load that is not too heaviness in the legs or arms (Mintarto, 2019) . In study This relevant with framework think that has developed based on supporting theories study This . With thus Speed training sawhorse zenkutsu dachi or sawhorse heavy front using development media zetras there is enhancement ability speed sawhorse zenkutsu dachi or sawhorse heavy front of Inkanas Karate athletes Banyuwangi .

Based on Exercise Which used For increase speed Front heavy stances use Zetras media . When carrying out exercises using assistive devices, the main thing that needs to be

considered is comfort. This indicates that there is a need for knowledge and understanding of the elements comfort in training for athletes and coaches is a necessity (Sutrisna et al., 2018) . With thereby from discussion on Zenkutsu dachi stance speed training or front heavy stance using Zetras development media there is an increase ability speed Zenkutsu Dachi stance or the heavy front stance of Inkanas Banyuwangi Karate athletes. As well as the ZETRAS (Zenkutsudachi Training Speed) modification tool to increase the speed of the front heavy stance for comfort when used for training by athletes .

CONCLUSION

Based on analysis results research and discussion can concluded that use the ZETRAS (Zenkutsudachi Training Speed) tool is effective in increase speed sawhorse heavy front karate athlete. Zetras media training model development tool later can used for all type karate stance. As well as the Zetras media development training model this can developed in components physique strength, due to research this only used for increase speed sawhorse heavy front of karate.

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Sustainable Aquaculture of Penaeus Monodon: IoT-Enhanced Automated Aeration System with Mobile Monitoring and Solar Panel Integration

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Keywords:
Shrimp
Penaeus Monodon
Dissolved Oxygen Levels
Automated Aeration
Venturi Pipe

ABSTRACT

The demand for Penaeus Monodon shrimp in Indonesia is significantly high. However, this demand is not matched by a high success rate in harvests, primarily due to the low survival rate of Penaeus Monodon shrimp, which directly impacts production quantities. The survival rate of these shrimp is highly dependent on dissolved oxygen levels. The minimum threshold of dissolved oxygen required for Penaeus Monodon to respire is 5 ppm. This level serves as the minimum threshold to prevent respiratory collapse and subsequent mortality. Therefore, we developed an IoT-based automated aeration system that monitors dissolved oxygen levels in real-time to maintain levels above 5 ppm by supplying air bubbles through a venturi pipe. This system operates continuously and autonomously, enhancing sustainability, as it is powered by solar panels. Based on monitoring results, 90% of the trials indicated that the system could automatically activate and supply air bubbles to maintain dissolved oxygen levels within a safe threshold.

INTRODUCTION

Shrimp is one of the fishery commodities that is highly sought after and in demand by the community (Waiho *et al*, 2024). Shrimp ranks first in Indonesian fishery exports with a contribution of 14.13 percent of export volume and 42 percent of export value to the national fisheries trade balance. In 2008, Indonesia was the third largest frozen shrimp exporter in the world after Vietnam and Thailand (C Yolandika *et al*, 2022). One type of shrimp that is the main choice for Indonesian people to cultivate is the Penaeus Monodon shrimp. The reason for choosing this type of shrimp is because it has the advantage of rapid growth compared to other types of shrimp (Amalia *et al*, 2022). This needs to be considered because the survival rate of shrimp cultivation is not as high as other commodities (Coman *et al*, 2007). Dissolved oxygen is the strongest factor that causes shrimp to suffocate, which has an impact on decreasing harvest yields (Zaini *et al*, 2020).

The application of advanced technology such as an automatic aeration system supported by the Internet of Things (IoT) will have a better impact on improving harvests because this system will help pond farmers to carry out regular monitoring and immediately react if the monitoring results of the dissolved oxygen level are below the previously set threshold (Vinod *et al,* 2021). The system components will consist of several main components, namely solar panels as an energy source, controllers with WiFi modules, dissolved oxygen sensors, combustion engines, venturi pipes and mobile applications, for more details can be seen in Figure 1.

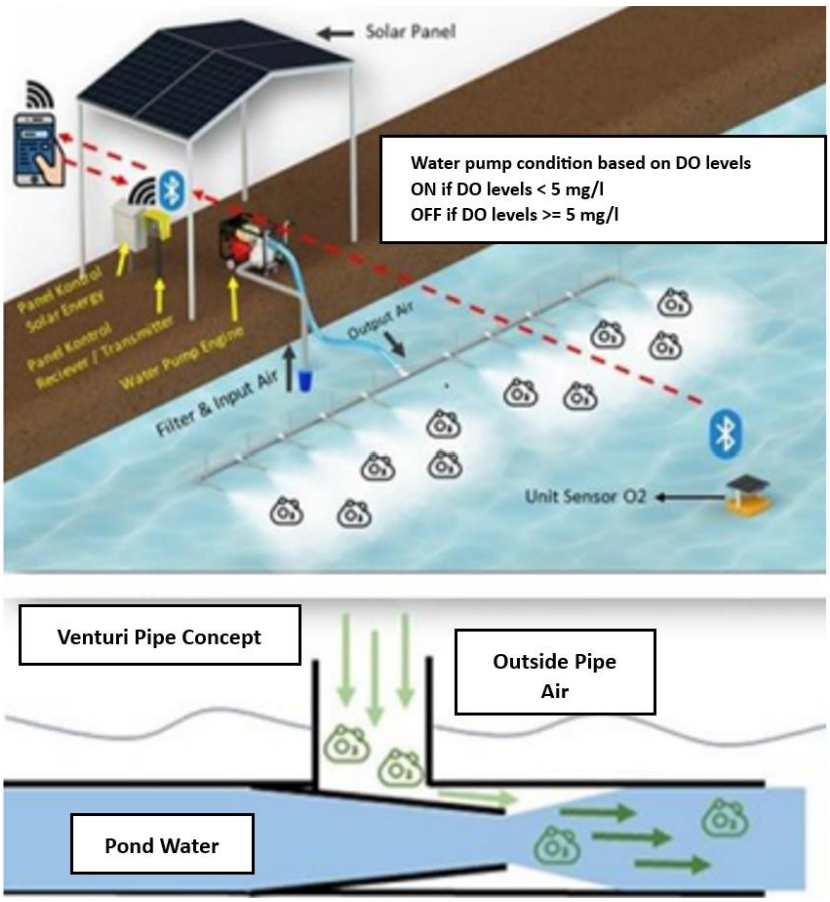

Figure 1. Pond Monitoring System Sketch

In figure 1 we can see that in flowing air to increase dissolved oxygen levels in strategic pond areas supported by a venturi pipe (Dange, 2023). The pipe that utilizes the thrust of air from around or outside the pipe that enters and is trapped then pushed by water that was previously sucked by the water pump so that it will create air bubbles that can maintain or increase dissolved oxygen levels if below the set threshold (Yadav *et al,* 2021). In this case, according to the experience of farmers in knowing the minimum limit of dissolved oxygen levels, researchers set a safe range of 5 mg/l, if below that value, the system will automatically turn on the water pump (Loyola *et al*, 2020).

RESEARCH METHOD

This system actually also relies on several sensors other than dissolved oxygen, including PH sensors and temperature sensors. However, the most influential on shrimp survival is dissolved oxygen, so that the water pump motor will react only from the dissolved oxygen level that has been set according to the safe threshold. The energy source in this system comes from solar panels that continue to supply power which is then stored in the battery. The electrical power will power several other components such as the controller and wifi module.

The system will be fully active if the sensor detects dissolved oxygen levels below the threshold, which is below 5 mg/l, so that the controller will be active and send a signal from the water surface area which is the location of the controller box and sensor module to be sent to the pump motor located in the pump house on the edge of the pond. After the motor receives a signal from the controller that the sensor level value has reached the safe threshold. When the signal has been received, the relay module will be active and distribute power to the water pump motor so that the motor will turn on and work to pump water to be distributed to the venturi pipe that has been placed on the water surface in the strategic pond area where the shrimp gather, in addition to the controller sending a signal to the pump motor, the controller will also send the sensing results to the monitoring application which can be viewed in real-time by the pond farmers.

This pond condition monitoring application has no limitations in distance and time of use, as long as the device is still on and has a good and stable internet network, then the pond farmers can monitor anytime and anywhere. In addition to monitoring, pond farmers can also turn on the motor directly through the application without waiting for the dissolved oxygen level to fall, if this is considered necessary by the pond farmers to be turned on. System details can be seen in figure 2.

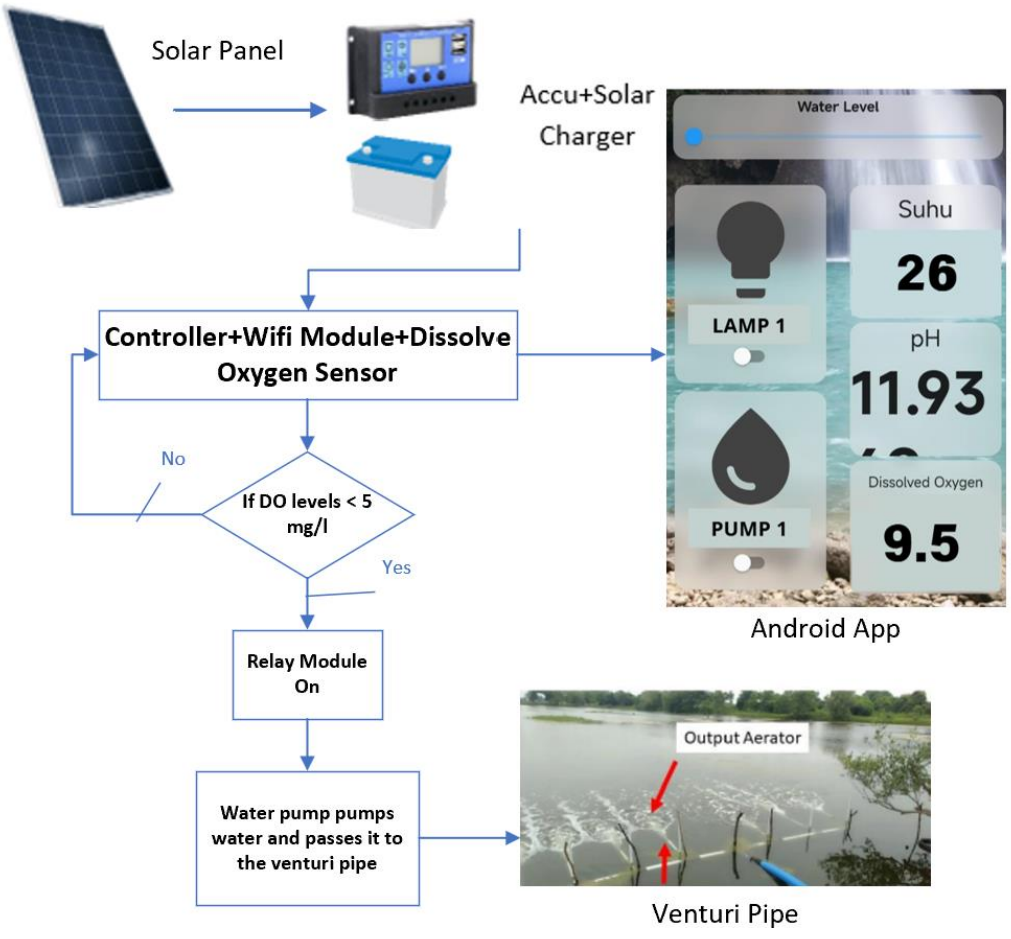

Figure 2. Pond Monitoring System Flowchart

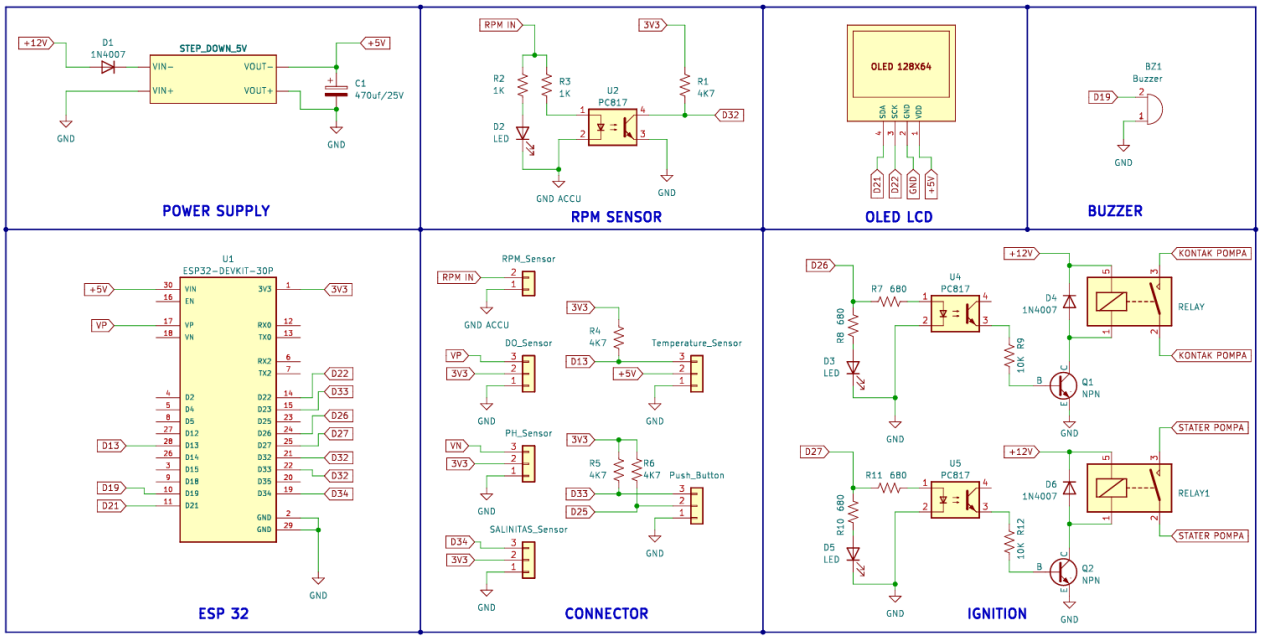

Figure 3. Pond Monitoring System Sketch

The circuit in the image is an IoT-based pond monitoring system designed using an ESP32 microcontroller to automatically monitor and control pond water quality parameters. The Power Supply module functions to reduce the voltage from a 12V input source to 5V using a step-down converter, ensuring a stable power supply for electronic components. The ESP32 microcontroller is the system control center, connecting various sensors and modules via I/O pins.

The Connector module includes the main sensors, such as an RPM sensor to monitor pump speed, a dissolved oxygen (DO) sensor to detect oxygen levels in the water, a temperature sensor to monitor water temperature, and a salinity sensor to measure salt levels. All of these sensors are connected via a connector to the ESP32 to read data in real time. Data from the sensors is processed and displayed via a 128x64 OLED LCD module, so users can see pond parameters directly. The system is also equipped with a buzzer as a sound warning device that will be activated if critical conditions are detected, such as a drastic decrease in oxygen levels or an extreme increase in temperature.

The Ignition module consists of a series of relays used to control the water pump. The relay is activated based on signals from the ESP32, which is triggered by reading certain parameters, such as turning on the pump when the oxygen level is below the threshold. In this section, indicator LEDs are used to provide visual information regarding the pump's operating status. The circuit also includes safety diodes to protect components from surges.

The system is designed to work efficiently with fast and responsive data processing. The combination of the ESP32 microcontroller, sensors, OLED display, and relays allows for smarter pond management, with automation that can improve water quality, optimize energy consumption, and maintain the stability of the pond ecosystem. In addition, this system can be expanded to support connectivity to IoT platforms, allowing remote monitoring via mobile device.

RESULTS AND DISCUSSION

This research was conducted for 24 hours starting from 07.00 until ending the next day at the same time by measuring several conditions such as the pH of the pond water, the surface temperature of the pond water, the dissolved oxygen levels and the reaction of the water pump when the oxygen level value reaches the predetermined threshold, for more details, see Table 1.

Table 1. Results of monitoring pond conditions

Time (24-Hour)	PH	*Temperature (^{O}C)*	*Dissolve Oxygen (mg/l)*	*Water Pump Condition (1=ON, 0=OFF)*
07.00	7.5	24	5,6	0
08.00	7,5	25	6,7	0
09.00	7,5	25	7,2	0
10.00	7,4	26	7,9	0
11.00	7,4	26	8,4	0
12.00	7,4	26	8,6	0
13.00	7,4	27	8,6	0
14.00	7,4	27	8,8	0
15.00	7,5	26	8,6	0
16.00	7,5	26	8,6	0
17.00	7,5	25	8,5	0
18.00	7,5	25	8,3	0
19.00	7,5	24	8,3	0
20.00	7,6	23	8	0
21.00	7,6	23	7,7	0
22.00	7,6	23	7,6	0
23.00	7,6	23	6,4	0
00.00	7,6	23	5,4	0
01.00	7,7	22	5	1
02.00	7,7	22	4,5	1
03.00	7,7	22	4,1	1
04.00	7,7	23	3,8	1
05.00	7,6	23	3,8	1
06.00	7,6	24	4,2	1
07.00	7,6	24	5,4	0

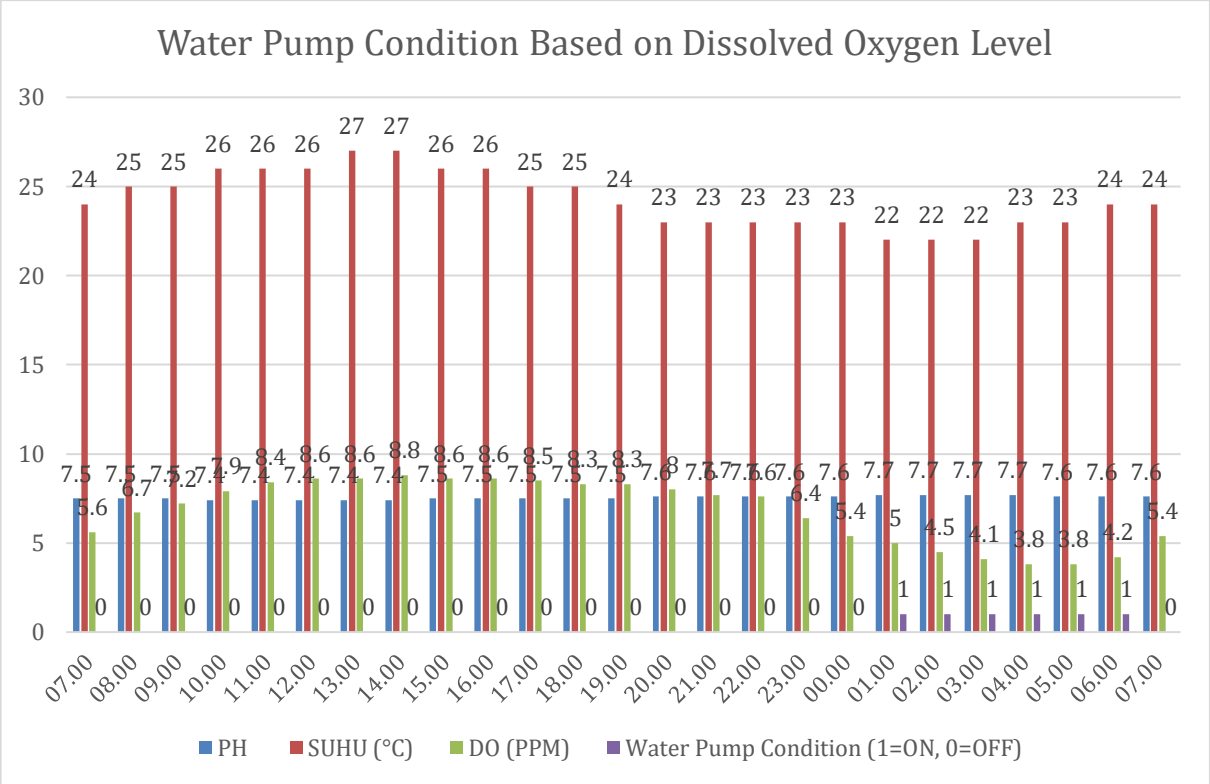

Figure 4. The relationship between water pump conditions and dissolved oxygen levels

Pond water management system using automatic pumps shows a close relationship between dissolved oxygen (DO) levels and water pump activation. In the morning to evening (07.00–19.00), DO levels are stable and high (5.6–8.8 mg/L), so the pump remains inactive because oxygen conditions are sufficient for the needs of pond biota. Photosynthetic activity by organisms such as phytoplankton is likely the main factor in maintaining DO during the day. However, at night to early morning (22.00–06.00), DO decreases drastically to a low of 3.8 mg/L due to minimal photosynthesis and increased oxygen consumption. As a result, the automatic pump is activated at 01.00 when DO drops below the critical threshold of 5 mg/L. Pump activation continues until DO increases again in the morning, indicating that this system is responsive to changes in water quality. In addition, water temperature ranges from 22–27°C and pH remains stable in the range of 7.4–7.7, reflecting an environment that supports the life of pond biota (Nandy *et al*, 2021). This system is effective in maintaining the balance of the pond ecosystem efficiently with pump activation only occurring at critical times.

CONCLUSION

The dissolved oxygen (DO) level-based water pump automation system has proven effective in maintaining pond water quality while increasing energy efficiency. Based on the data, the pump is active when DO drops to 4–4.5 ppm and turns off again after DO reaches an optimal level above 5 ppm, ensuring adequate water circulation without

wasting energy. The DO level is stable during the day at around 7 ppm due to photosynthesis activity, but decreases at night and early morning due to increased oxygen consumption by pond biota. The water temperature is within a safe range (22–27°C) with a stable pH of 7.6–7.7, indicating a balanced ecosystem condition (Pantjara *et al*, 2021). With the pump operating only when needed, this system not only maintains the survival of pond biota but also supports ecological and economic operational sustainability, making it an ideal solution for IoT-based pond management.

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Mobile-Driven Disease Identification System for Rice Plants Using ResNet

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Keywords:
agriculture, rice plant, resnet, mobile, adamax optimization

ABSTRACT

Rice is one of the staple food sources of the Indonesian people. Rice is one of the staple food sources of the Indonesian people. However, rice production in Indonesia has decreased significantly. This has led to more rice imports in Indonesia. It makes Indonesia more dependent on other countries. The main factor in the crop failure of rice is disease. Agricultural experts are still lacking in Indonesia. This makes the problem of crop failure persist. Therefore, we developed a mobile-based system to identify rice plant diseases. It provides treatment advice for infected plants. This system works in reference to one of the artificial intelligence methods, namely convolutional neural networks. The system is programmed to learn and recognize interconnected networks that form a pattern. So that it can understand similar patterns in different images. In this study, we used the ResNet-50 model with Adamax optimization. It got a training accuracy of 99.94%. To use this application, users only need a smartphone and do not need any internet access. The app has high mobility and easy access for farmers during fieldwork activities. It can solve the problem of crop failure. It's especially helpful in rice fields.

INTRODUCTION

Rice is a staple food in many parts of the world, especially in Asian countries. According to statista.com, as of 2022, China has the most rice. It produces 208.49 million tons. India is in second with 196.25 million tons. Through this data, rice production in Indonesia in 2022 is 54.75 million metric tons. It ranks fourth in the world (Shahbandeh, 2022). Low production in 2023 and export limits from producing countries threaten national food security. According to the Institute for Development of Economics and Finance (InDEF), countries that do not have sufficient food security will have difficulty controlling inflation. Poor food security will make it difficult for the country to have good stability, it involves high inflation rates.

The unmet need for food is a big problem. It causes more hunger and malnutrition. It can also harm the country's economy. Based on the Area Sampling Frame survey (KSA) BPS-STATISTICS INDONESIA data, the harvest area in February 2023 was only 940 thousand ha. Indeed, it increased from the position in January 2023 which was only 448,000 ha and jumped from February 2022 which was recorded at only 767,000 ha. Thus, national rice production in February 2023 was only 2.86 million tons. While January 2023 was only 1.33 million tons. This means that there is a shrinkage of around 802,000 tons from the government's estimate of around 3.68 million tons.

One of the reasons is flooding due to high rainfall in February 2023. Where the BMKG analysis states normal to above normal rainfall. As a result, 31 thousand ha of paddy fields experienced crop failure. While the projected national monthly consumption reached 2.54 million tons, in January 2023 RI experienced a rice deficit of 1.2 million tons and in February 2023 a rice surplus of 320 thousand tons (Pertanian, 2016). The high number of crop failures in Indonesia has increased the number of rice imports. To overcome this, rice productivity must be increased immediately. Such as increasing farmer education about technological innovations in agriculture, which can be applied in

optimizing plant and animal production, managing resources efficiently, and improving the quality of agricultural products.

Rice has the scientific name Oryza sativa L. is a cultivated plant that is easily found in agrarian countries such as Indonesia. Although a cultivated plant, rice also has plant species that can live wildly in nature. Based on the variety, rice in Indonesia is divided into three varieties, namely hybrids which are single-plant rice, superior varieties are rice that can be planted many times with the same quality as its derivatives, and local varieties are rice with special types that can only breed in certain areas (Tonael, Kaesmetan, & Lamabelawa, 2021). Common rice plant diseases in Indonesian agriculture include tungro, blast, bacterial leaf blight, sheath blight, and brown spot, each with varying degrees of severity, requiring prompt and accurate identification (Rani & Singh, 2022). Rice plants often face issues like pest or disease attacks, leading to plant death and harvest failure. Therefore, proper handling is essential to address these issues. One approach is to detect diseases in rice plants, enabling farmers to take appropriate action (Santosa, Fu'adah, & Rizal, 2023).

The development of a mobile-based rice plant disease identification system is very important in providing a quick and effective solution to detect plant diseases early, especially for farmers. Considering that sometimes farmers in Indonesia still need experts in the process of identifying rice plant diseases, whose availability is not always certain so that it can hamper agricultural activities, a system is needed that can replace the role of an expert to facilitate agricultural activities. With a system that can be accessed via smartphone without an internet connection, farmers can periodically check the condition of their crops. This makes it possible to detect diseases early and take timely preventive or treatment measures, thereby reducing crop losses. By utilizing the Transfer learning method, which is an approach that allows the reuse of knowledge that has been learned by the model from previous tasks, it is hoped that this system can provide maximum benefits. In this context, the model used is ResNet, a convolutional neural network (CNN) architecture that has proven effective in a variety of computer vision tasks, including object identification in images.

By using transfer learning, we can utilize the knowledge that the ResNet model has acquired from training on large and varied datasets. The ResNet model has successfully extracted useful features from complex images, including images of rice plants. Then, this acquired knowledge can be used to speed up the training process of the rice plant disease identification model. In addition to providing solutions for farmers, the development of this system is also expected to support the growth of the agricultural sector in Indonesia. By utilizing easily accessible technology such as smartphones, it is expected that this system can be widely applied by farmers in all regions of Indonesia, even in remote areas. This will help increase productivity and efficiency in the agricultural sector, as well as contribute to the country's food security.

1.1 Convolutional Neural Network

As we know the development of Artificial Intelligence (AI) is now increasingly widespread. By utilizing AI in one of its researches called deep learning, which allows computer programs to learn data without human intervention in making accurate predictions. In this research we use the Convolutional Neural Network (CNN) is one of

the deep learning methods that teach computers to process data in a way inspired by the human brain. The computer will learn to form a pattern from each connected network from large amounts of data. The pattern that has been learned is called a model. The model is used over the object to be recognized (Via, et al., 2023). as illustrated in Figure 1

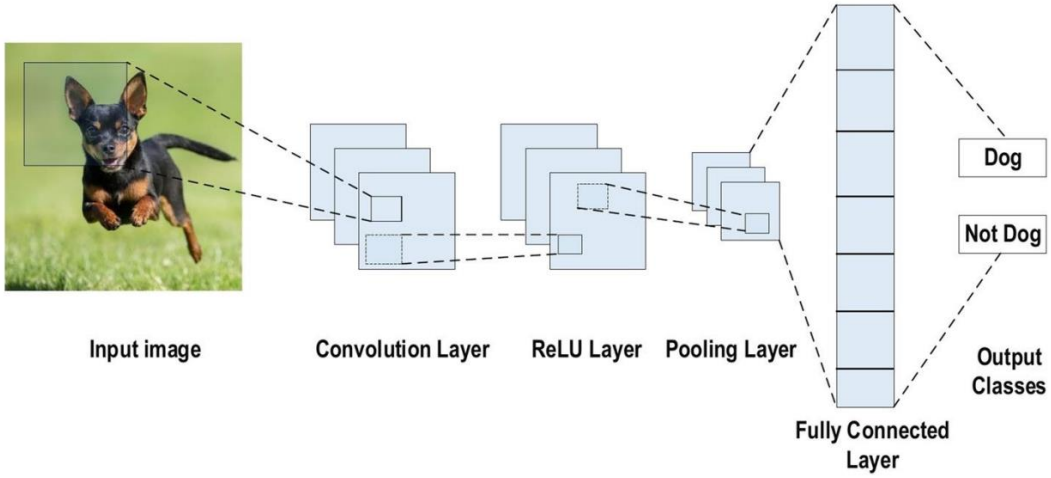

Figure 1. CNN Architecture

Source: (Alzubaidi, et al., 2012)

1.2 ResNet-50

ResNet (Residual Networks) is one of CNN (Convolutional Neural Network) architecture. There is 4 Key Components of Resnet Architecture. The first key is residual block, in residual block the inputs to the block are added to the outputs of the block creating a residual connection. The second key is Skip connection, consists of the residual block's input. It passes through the convolutional layer and is added to the residual block's output. The third key is stacked layers, the ResNet architecture forms by stacking multiple residual blocks together. And the last key is global average pooling (GAP) is the last layer before the fully connected leyer. GAP reduces spatial dimensions to a single value per feature map providing a compact representation of the entire feature map (Azeem-I, 2023). In this research we use ResNet-50. It has 50 bottleneck residual blocks, which are stacked. The initial layer of the network features a conventional convolution layer and a pooling layer to perform image preprocessing before undergoing further processing by the residual blocks. Finally, a fully connected layer positioned at the top of the structure utilizes the enhanced data to categorize the image with precision (Shah, Qadri, Shah, Sharif, & Marinello, 2023). An illustration of the Resnet 50 architecture can be seen in Figure 2.

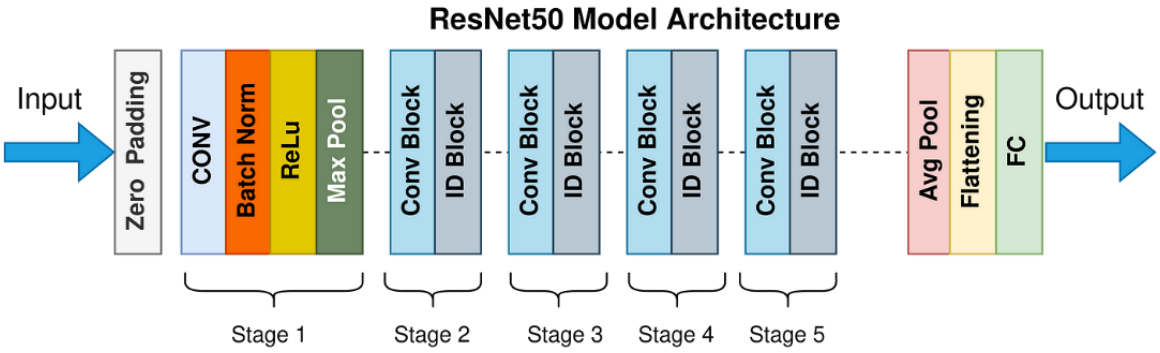

Figure 2. ResNet-50 Architecture

Source: (Mukherjee, 2022)

RESEARCH METHOD

This research was designed through several stages obtained through adaptation of two methodologies, namely IBM Data Science Methodology as a reference analysis method and Waterfall Methodology as a reference method for application development. as illustrated in Figure 3.

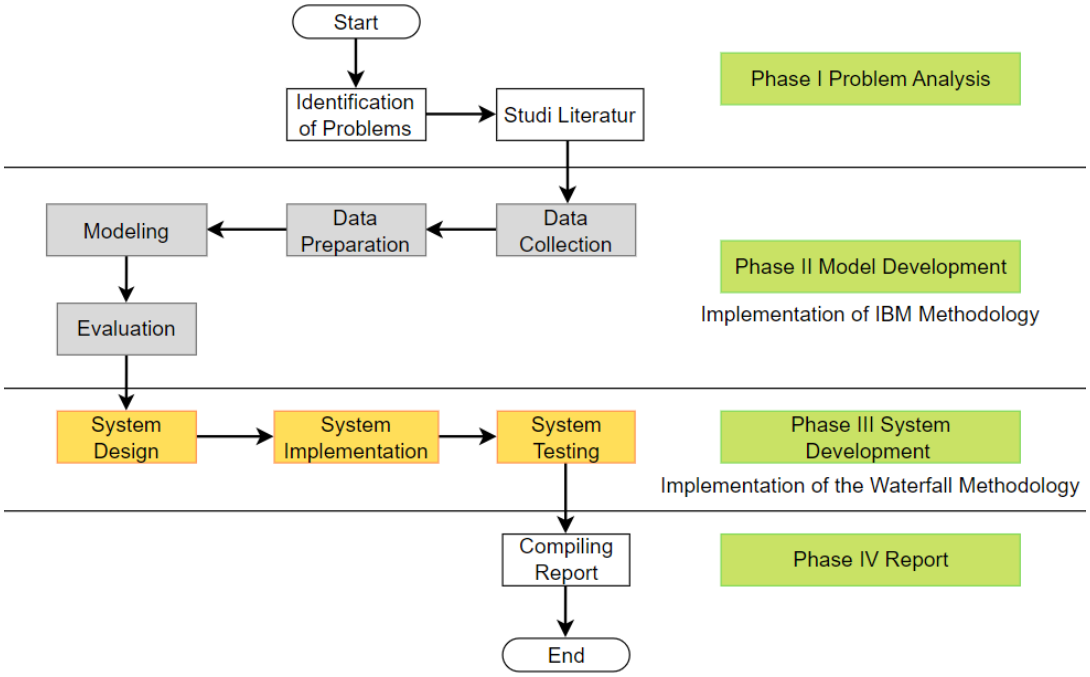

Figure 3. Research Flow

2.1 Phase I Problem Analysis

The This research was designed through several stages obtained through adaptation of two methodologies, namely IBM Data Science Methodology as a reference analysis method and Waterfall Methodology as a reference method for application development.

2.2.1 Identification of Problems

This research begins with the problem analysis stage, which is the first step in the research process. This analysis includes topic selection, determining the problem formulation, and determining research objectives, which will be supported by

literature studies related to the topic of disease identification in rice plants using the ResNet model. This problem analysis stage is an important foundation that will guide the next steps in this research.

2.2.2 Study Literature

The next step is a literature study, where researchers search for references and literature related to the research topic, such as books, journals, articles and other online sources. The aim is to understand theoretical concepts, research methodology, as well as relevant findings related to research subjects, such as types of rice plant diseases, the use of deep learning technology in identifying rice plant diseases, and the application of the ResNet model.

2.2 Phase II Model Development

The second stage is model development. The steps in this stage adopt an approach from IBM Data Science Methodology, especially in data processing and solution creation. There are four main steps taken in this stage, namely:

2.2.1 Data Collection

Data collection carried out in this research was divided into 2 stages, namely by collecting images of rice plant leaves as material for system experiments. And collecting data sets to carry out model training which can be accessed on the kaggle.com website with the title "Rice Leaf Disease Detection".

2.2.2 Data Preparation

After The data preparation process is the stage of preparing the data after it has been collected and then processed using a predetermined model. This process goes through 3 stages, namely cleaning data, where the collected image will be adjusted by cropping the background, increasing contrast, or adjusting color to increase sharpness of detail. Data augmentation, where variations are added to the resulting training dataset by carrying out transformations such as rotation, shift, shear, zoom and horizontal flip on the image. Annotation, which is the stage of giving labels or other information to certain objects or areas in the image. This entire preprocessing process is an important step in preparing the dataset for model training.

2.2.3 Modelling

The model development in this research was carried out using Google Colab, the following are the stages of model development. Start by selecting the ResNet model to use. This algorithm consists of several layers of stages, namely pre-trained model, feature extraction model, and fully connected layer. Optimize the model with the Adam Optimizer algorithm to train the model and adjust parameters such as learning rate according to needs. Then train the model using the previous training data, and set hyperparameters such as learning rate,

number of epochs, and size. Then the model will be saved in tflite format which can be integrated with the Flutter framework.

2.2.4 Evaluation

After all stages are trained, evaluate the performance of the model to ensure good performance in detecting objects in various image conditions. In this study, the evaluation is carried out using the Confusion Matrix method using several equations presented by (Kundu, 2022) as follows:

1. Accuracy, describes how accurately the model can classify correctly.

$$accuracy = \frac{TP + TN}{TP + TN + FP + FN} \quad (1)$$

2. Precision (Positive Predictive Value), describes the level of accuracy between the requested data and the prediction results provided by the model.

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

3. Recall or Sensitivity (True Positive Rate), describes the success of the model in retrieving information.

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

4. F1 describes the balance between Precision and Sensitivity (Recall) which provides information on how well the model has been created.

$$accuracy = \frac{TP + TN}{TP + TN + FP + FN} \quad (4)$$

2.3 Phase III System Development

After building the model using the Python programming language. At this stage of development of this mobile information system, the language used is Dart in the Flutter framework. This difference in the programming languages used can be overcome by using the Tensorflow library. Where the output of the model created in the form of an h5 file will be converted into tensorflow's tflite which can be read by the flutter framework. In this stage, the waterfall model is used as a system development model.

2.3.1 System Design

This step involves designing the system based on the needs analysis that has been carried out previously. In this research, the system will be designed using the mobile-based Flutter framework as an application that will be used by users. In the application, users can input images using a camera or select images stored in the gallery. Then the image will be analyzed using the model that has been

created, which outputs the identification of rice plant diseases and how to overcome them. Illustration of the workflow can be seen in Figure 4

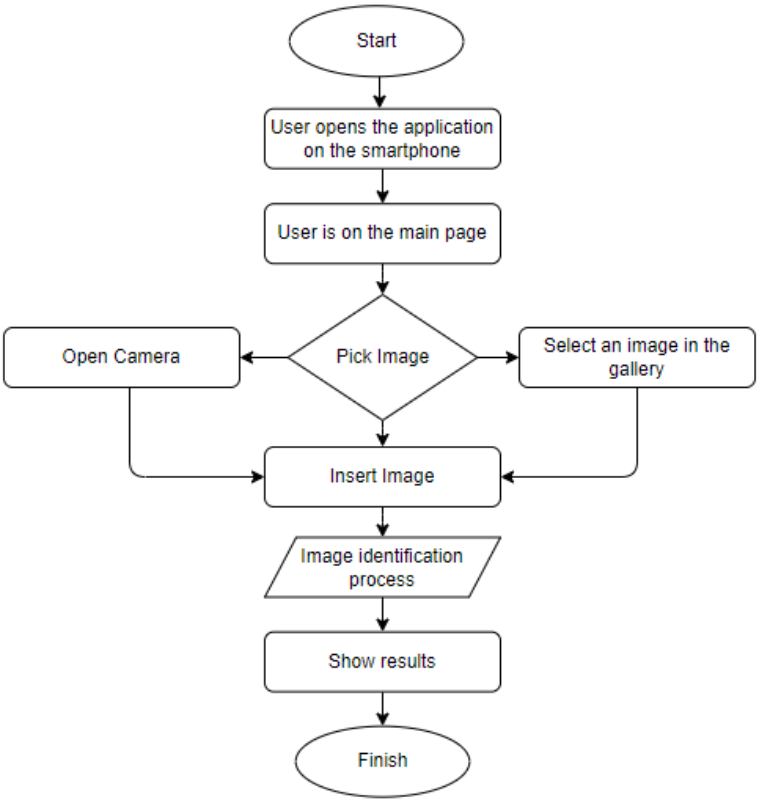

Figure 4. Workflow Diagram

2.3.2 System Implementation

This stage is the implementation of the system based on the previously created design which involves the process of compiling mobile application code using the flutter framework. This application is intended for users to input which then the image will be analyzed using a model that has been stored in *.tflite format and the results of the analysis are issued along with suggestions for actions that must be taken.

2.3.3 System Testing

After the implementation is complete, the system will be tested to ensure that all features function properly and in accordance with the system design that has been made. In this stage we use 2 tests, Black Box testing and model testing. Testing is done by observing the input and output results. Furthermore, the system testing stage is carried out on the disease identification system in rice plants to test the model in detecting diseases in rice plants.

2.4 Phase IV Reporting

The final stage of this research is the preparation of the report. After the application development stage is complete, the final step is stage IV, namely Reporting, where the results of research and system implementation will be compiled in the form of a complete and structured report for documentation and publication purposes.

RESULTS AND DISCUSSION

Model development is made through the google collab application with data collection from Kaggle. Website development is made through the vscode application with the flask framework for website display and integration with data analysis modeling. The following is an explanation of both points: Data collection, model development, system implementation, and evaluation.

3.1 Data Collection

Data collection carried out in this study is divided into 2 stages: collecting images of rice plant leaves as material for system experiments and collecting data sets to perform model training that can be accessed on the kaggle.com website with the title "Rice Leaf Disease Detection".

Table 1. Dataset

No.	Class	Number of Images
1	Bacterial Leaf Blight	1.386
2	Rice Hispa	1.464
3	Brown Spot	1.480
4	Neck Blast	993
5	Healthy Rice Leaf	1.491
6	Narrow Brown Leaf Spot	1.416
7	Leaf Blast	1.639
8	Sheath Blight	1.578
9	Tungro	1.690
Total		13.135

3.2 Model Development

We develop the model using ResNet 50 structure, we trained the model for 20 epochs which lasted for 1 hour 19 seconds, with the best results obtained at the 17th epoch with an accuracy value of 99.948 and a loss value of 0.265, To determine the performance of the model that has been trained previously, it is necessary to evaluate the model by displaying the overall model performance graph and visualizing the model training data. The learning progress of the model on the training dataset is visualized by a line graph. The figure 5 is for loss value and figure 6 is for accuracy value.

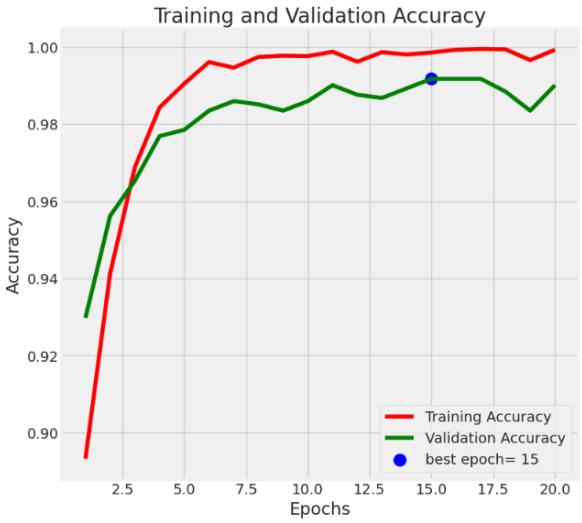

Figure 5. Training and Validation Accuracy

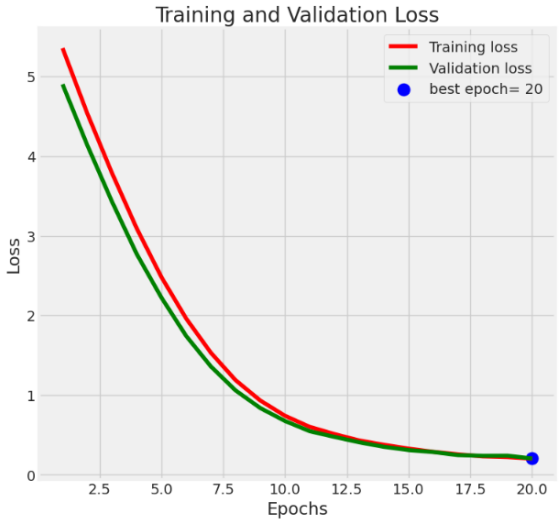

Figure 6. Training and Validation Loss

After modeling, an evaluation of the model is carried out using confusion matrix calculations for each class in the dataset. Which can be seen in the classification report in fig 7. The calculation such as precision, recall, f1-score, and support refer to the basis of the calculation of evaluation matrix. The highest value obtained is 100% and the lowest value obtained is 99%.

	precision	recall	f1-score	support
Bacterial Leaf Blight	1.00	0.99	1.00	119
Brown Spot	1.00	0.99	1.00	155
Healthy Rice Leaf	1.00	1.00	1.00	109
Leaf Blast	0.99	0.99	0.99	175
Leaf scald	0.99	0.99	0.99	133
Narrow Brown Leaf Spot	1.00	1.00	1.00	95
Neck_Blast	1.00	1.00	1.00	100
Rice Hispa	1.00	1.00	1.00	130
Sheath Blight	0.99	1.00	1.00	163
Tungro	1.00	1.00	1.00	31
accuracy			1.00	1210
macro avg	1.00	1.00	1.00	1210
weighted avg	1.00	1.00	1.00	1210

Figure 7. Classification Report

Then a confusion matrix diagram is needed to evaluate the performance of the model by running the model on the testing dataset which can be seen in Figure 8

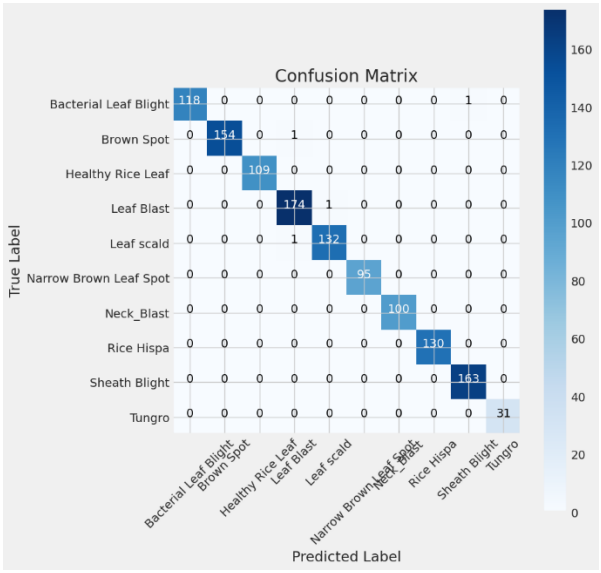

Figure 8. Confussion Mattrix

In the diagram above the true label takes data from the training dataset, and the predicted label takes data from the testing dataset. from the diagram there is a loss in 1 rice hispa data detected as bacterial leaf blight, 1 leaf scald data detected as brown spot, 1 leaf scald data detected as leaf blast, and 1 leaf blast data detected as leaf scald.

3.3 System Implementation

System implementation is carried out after the system design is made for reference. Which in this study the design of a mobile information system is made using the Flutter framework, consists of 4 pages. As shown in the picture below which is the first and second onboarding is a page that used as a brief introduction to the application to users

Figure 9. onboarding 1

Figure 10. onboarding 2

Furthermore, there is a homepage, on this page users can input images by opening the camera and taking pictures directly or selecting images in the gallery. and the last is the detection result display, on this display the user gets the detection results of the image

that has been entered. There is a back button on the top right and bottom center which functions to return the display to the homepage so that users can repeat the image capture process.

Figure 11. homepage

Figure 12. resultpage

After implementing the system and modeling, the model was integrated into the system using the tflite package, the following tests were carried out after system integration.

Figure 13. the prediction result is correct

Figure 14. the prediction result is correct

Figure 15. the prediction result is correct

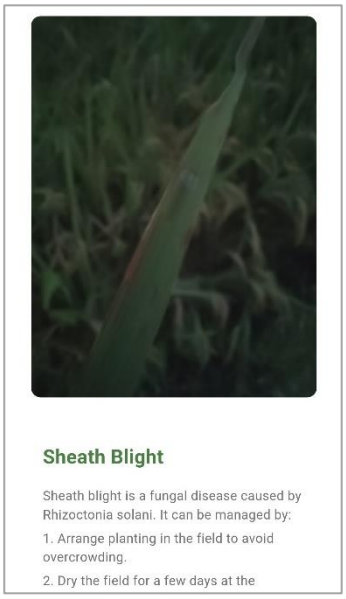

Figure 16. the prediction result is not correct

From 4 final product tests that have been carried out show that the prediction results run well, but there is 1 that is not correct, this is because the quality of the input image is not good, in this case the image is experiencing a lack of light so that the identification process is not correct.

CONCLUSION

This research uses deep learning as the main method in machine learning to recognize objects in the form of images, by utilizing the ResNet-50 model as the foundation in developing deep learning structures. In the development of this model, the Adamax optimization algorithm was also used to improve the overall performance, which resulted in a significant improvement in the accuracy of the model to reach 99.95% and the lowest loss value reached 0.265. The developed model was successful in the task of disease detection in rice plants, demonstrating its ability to provide consistent and reliable results in visually analyzing plant conditions. Thus, the implementation of deep learning with ResNet-50 and the application of Adamax optimization algorithm become an effective foundation in providing smart solutions to support the success of agriculture through technology. The development of this rice plant disease identification system was carried out using the Flutter framework for the Android mobile platform. This process involved the design and development stages of the system as a whole, where model integration became a crucial part of the development process. Model integrity in the system is done through conversion to the TFLite format, which allows the model to be optimized for performance on mobile devices. During this process, the model was properly annotated in order to be implemented in the rice plant disease detection system. The result of successful integration is a system that is able to produce outputs in accordance with the application requirements, providing users with accurate and reliable information regarding the health condition of rice plants.

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Evaluation of Pedestrian Pathway Design for Accessibility for Disabilities to Support SDGs and Reduce Carbon Emissions

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Keywords:
Accessibility
Carbon emissions
Disabilities
Pedestrian pathway
SDGs

ABSTRACT (9 pt)

People with disabilities have the same right to access public spaces as the public in general. One of the crucial elements of the design of urban public spaces is pedestrian paths. This research was conducted on designing pedestrian paths for people with disabilities in the socio-cultural strategic area of Yogyakarta City. The sample taken was from the Kota Baru area along Jalan Suroto. This research uses an observational quantitative descriptive method through field surveys and literature studies with the stages a) segment determination, b) data collection, c) data evaluation, and d) recommendations. This study has divided the pedestrian pathway into 4 segments. The final results were obtained for segment 1 to receive quality II (High), segment 2 to receive quality I (Very High), segment 3 to receive quality II (High), and segment 4 to receive quality I (Very High). From the results of this research, it is hoped that the quality and accessibility of pedestrian pathways can be improved, creating a safer, more comfortable, and inclusive environment for all users. Eventually, this can also reduce the use of private vehicles, thereby decreasing traffic congestion, air pollution, and carbon emissions.

INTRODUCTION

The high density due to the many existing activity centers also increases mobility, so it needs to be supported by adequate city facilities and infrastructure to facilitate accessibility (Fatimah & Fadhilah, 2021; Fitriana, 2016). Accessibility concerns society in general and, in particular, people with disabilities. People with disabilities are individuals who face physical, mental, or sensory limitations over a long period. They face challenges interacting with the surrounding environment and experience difficulties fully participating due to impaired physical movement functions (Dewang, 2010; Maftuhin, 2016).

Yogyakarta is one of the cities with a very high population density. The Central Statistics Agency projects that the population of Yogyakarta in 2023 will be 455,535 people with an area of 32.5 KM2 so that the population density will be 14,016 people/KM2 (Badan Pusat Statistik, 2023). As for the number of people with disabilities, the Yogyakarta City Government recorded the number of people with disabilities in Yogyakarta City as many as 3,447 people (Warta Jogja Kota, 2022). Although the percentage of people with disabilities in Yogyakarta City is relatively low, the existence of unique communities like theirs still needs special attention to provide comprehensive protection and fulfillment of disability rights by applicable regulations nationally and globally, one of which is with adequate public space facilities. Public space is a space for mobility and economic activities and must be accessible to all (Pineda, 2022).

Persons with disabilities have the same right to access public spaces as the public in general to realize equal opportunities in life and livelihood (Perda Kota Yogyakarta No.4, 2019; Pujianti, 2018; Qur'ana & Priyono Purnomo, 2020). This is in line with the programs launched by the United Nations through the Sustainable Development Goals (SDGs) program. It is crucial to carry out infrastructure development by considering quality,

reliable, sustainable, and resilient infrastructure, including regional and cross-border infrastructure, to support economic development and human welfare, focusing on affordable and equitable access for all (United Nations, 2015). This includes ensuring that facilities for the general public, such as city and city streets, are available equally for persons with disabilities and responsive to their needs (United Nations Committee on the Rights of Persons with Disabilities, 2014). Local and regional governments and other key urban stakeholders face immense pressure to adapt urban planning and design strategies, policies, and practices to fully respond to the rights and needs of all persons with disabilities and intersecting social groups (Lagrelius & Bravo, 2022). Although Indonesia guarantees disability rights through various government regulations, it does not have clear sanctions if disability rights are not implemented in the field (Puspita Sari & Soeskandi, 2022). This is a serious problem because the regulations have become vague. The level of accessibility of an urban area can be measured based on several variables, namely the availability of road networks, the number of means of transportation, the length and width of roads, and the quality of roads (Fatimah & Fadhilah, 2021). The design of road network planning and good implementation can create complete streets. The term complete streets refers to roads that can accommodate various road users of various ages and with various abilities. In addition, the road in question must be safe, comfortable, and designed according to the needs of the various groups (ITDP Indonesia, 2019). According to Hamid Shirvani, an urban design expert in Mukti (2015), one of the important elements that are part of urban design is pedestrian paths. The basis for pedestrian path planning in Indonesia, especially adequate for people with disabilities, has been regulated in laws such as the Minister of PUPR No. 03/PRT/M/2014 (2014) and PUPR No. 14 PRT/M/2017 (2017). Globally, there is a Global Street Design Guide (2016) and other related research, such as Ergonomic Standards For Pedestrian Areas For Disabled People. (Berrett et al., 1998)

Looking at these problems, especially related to accessibility for people with disabilities, one of which is through pedestrian design, it is important to evaluate the design of existing pedestrian paths. Whether the pedestrian path is adequate and friendly for people with disabilities in accordance with the applicable laws and regulations and what solutions can be offered are the main points to be researched. Good pedestrian planning is also linked to sustainable infrastructure development. Research shows that pedestrian paths that are integrated with public transportation systems can improve accessibility and reduce the need for private vehicles (Arifin & Yusuf, 2021). By facilitating better access to public transportation, cities can reduce traffic congestion and emissions resulting from vehicles. In addition, planning that considers environmental aspects, such as the use of environmentally friendly materials and designs that pay attention to airflow, can also contribute to the reduction of carbon emissions (Lestari & Muazir, 2021)

RESEARCH METHOD

This research was conducted on designing pedestrian paths for people with disabilities in the socio-cultural strategic area of Yogyakarta City. The sample taken is the Kota Baru area along Jalan Suroto, which is included in the strategic socio-cultural area of Yogyakarta City and is listed in Yogyakarta City Regional Regulation No. 2 of 2021. The pedestrian on Jalan Suroto is new due to revitalization completed in 2018. Head of the

Jogja City Housing and Residential Areas Public Works Office (DPUPKP) Umi Akshanti said the pedestrian path on Jalan Suroto is conceptualized as disability-friendly. Therefore, the location is interesting for evaluating the pedestrian design and whether it is in accordance with the initial planning and is friendly to disabilities. This research method uses an observational quantitative descriptive method through field surveys and literature studies with the stages a) segment determination, b) data collection, c) data evaluation, and d) recommendations.

Segment

Segment division facilitates the research process based on road location. It involves dividing the road that is cut off by another road or at the intersection meeting into subdivisions. The results of the segment division in this study are depicted in Figure 1.

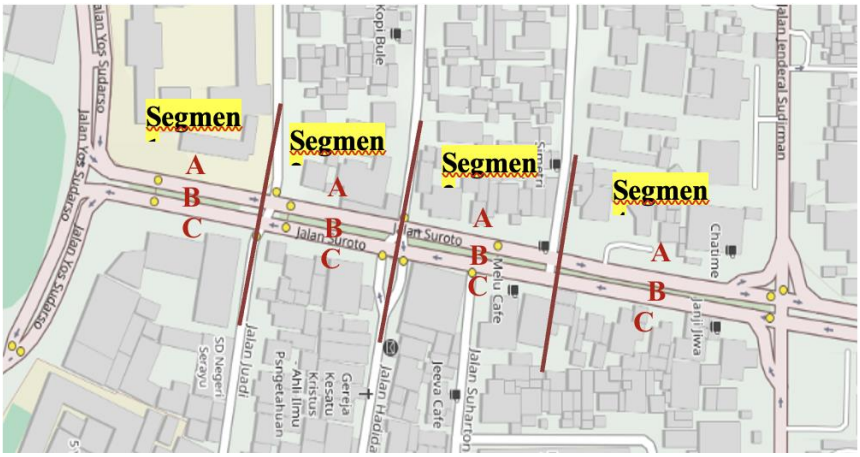

Figure 1. Segmentation

Data Collection

The method of data collection by conducting observations is mapping pedestrian elements, dimensional measurements, and documentation along the Suroto road. Observations focus on design and structural aspects in view of ease of access for people with disabilities, using instruments that have been made and compared with the theory and standards of applicable design regulations.

Data Evaluation

The primary data that has been obtained is then processed or evaluated in the form of digital images, mapping, and descriptive images in the form of narratives or tables based on the instruments that have been used. The research instrument developed refers to the pedestrian design standards of the Minister of PUPR No. 03/PRT/M/2014, the Minister of PUPR No. 14 of 2017 and adopts the Ergonomic Standards For Pedestrian Areas For Disabled People by Berrett et al. (1998). The assessment instruments can be seen in Table 1.

Table 1. Research Instrument

N	Design Features	Values for each Disability Group (Berret et all, 1998)			Condition Category	V
		Walking problem	Wheelchair Users	Blind		
A	**Access to an Area**					
1	Parking	M	V	M	Parking area available	1
					No parking	0
2	Public Transport	M/V	V	V/L	Any public transport	1
					No public transport	0
B	**Movement into area**					
1	Crossing the Road	V	V	V	Exist	1
					None	0
2	Movement Distance	V	V	M	> 3 m	4
					2.1 - 3 m	3
					1.5 - 2 m	2
					<1.5 m	1
					no sidewalk	0
3	Surface type and condition	V	V	V	no impediments in the surface	3
					few impediments in the surface	2
					significant impediments in surface	1
					no sidewalk	0
C	**Mobility within area**					
1	Furniture					
	a. Chairs	L	M	V	Exist	1
					None	0
	b. Distance				< 9 m	3
					9 m	2
					> 9 m	1
					None	0
	c. Tall				< 0.45 m	3
					0.45 m	2
					> 0.45 m	1
					None	0
3	Ramps and Curbs	V	V	V/M		
	a. Existence				Exist	1
					None	0
	b. Simplicity				< 8%	3
					8%	2

N	Design Features	Values for each Disability Group (Berret et all, 1998)			Condition Category	V
		Walking problem	Wheelchair Users	Blind		
					> 8%	1
					None	0
	c. Wide				> 1.2 m	3
					1.2 m	2
					< 1.2 m	1
					None	0
D	**Interface with services and facilities**					
1	Toilet	L	L	V	Exist	1
					None	0
	Information provision					
	Guiding block				Guide tiles along the strip	2
					Partial lane guide tiles	1
					None	0
2		L	L	V	Warning tile of each intersection	2
	Warning block				Warning tile only part of the intersection	1
					None	0

Keterangan:
V = Very Important
M = Medium Important
L = Low Important
M/V = Medium/Very Important
L/V = Low/Very Important

$$\text{Feasibility Percentage}(\%) = \frac{\text{Observed Score}}{\text{Expected Score}} \times 100\%$$

Table 2. Assessment Indicators

Class	Value	Category
I	81-100	Very High Quality
II	61-80	High Quality
III	41-60	Average quality
IV	21-40	Minimal Quality
V	1 - 20	Poor Quality

Recommendation

The final stage is to make recommendations on aspects of design assessment that do not meet the standards. Recommendations are suggestions and criticisms of the overall design concept.

RESULTS AND DISCUSSION

The results of direct observation in the field found that each segment consisting of sub-segments received a quality class score in the lowest range of level II (High) and the highest level I (Very High). This means that the Suroto road section has good pedestrian quality and provides easy access for people with disabilities. However, some parts still have shortcomings and need to be improved (Rose et al., 2020).

Evaluation of Pedestrian Design Aspects

Almost all indicators get a high maximum score from segments 1 - 4 on Jalan Suroto. While some indicators have inconsistent score results, this can be seen from the results of different scores in each sub-segment. Among them are the distance of the seats, the existence of toilets, the condition of the pedestrian surface, and the width of the pedestrian. The score data for each sub-segment is then made into a score distribution graph, which can be seen in Figure 2 below. This distribution data is used to facilitate the analysis of the decline and increase in the score of each sub-segment. It can be seen that the difference in the results of each sub-segment is quite significant. Only segments 2C-3A and 4B-4C have the same score. From the distribution results, it can be concluded that even though the pedestrian work process is at the same time, it turns out that the results obtained have differences or gaps.

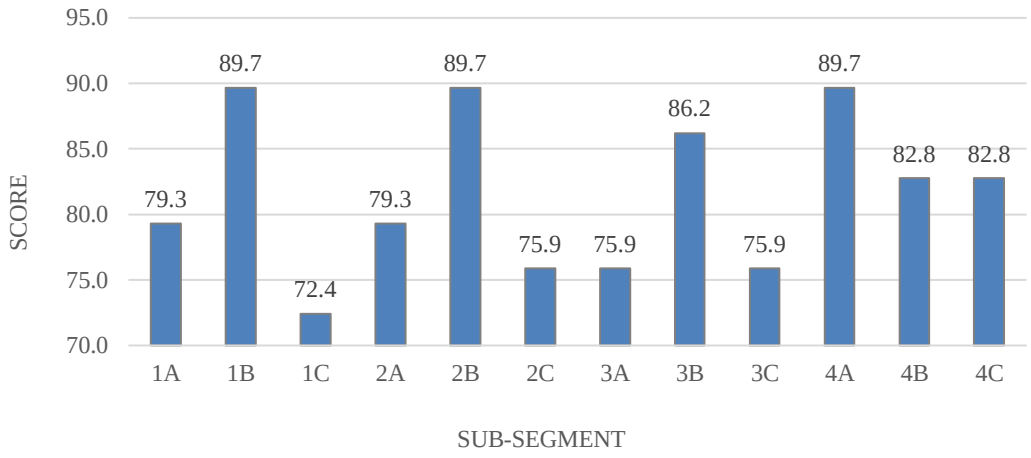

Figure 2. Sub-segment scoring score distribution graph

Based on field results data and referring to the standards according to the Minister of PUPR (2014 and 2017), further analysis was carried out on indicators that had low-value results. The first indicator is the distance between the seats along the pedestrian. The regulations have provided a rule that the distance of the seats must not be more than 9 meters. Meanwhile, the locations in sub-segments 1B, 2B, 3A, 3C, and 4B do not meet the standards where the distance between seats is more than 9 meters. The biggest factor is the existence of shophouses along the pedestrian path, so the seating area is reduced due

to being used as access to the shophouse. This results in a longer distance between the seats.

The second indicator is the condition of the pedestrian surface. In segments 1C, 2C, 3A, 3C and 4C there are road facilities that reduce the width of pedestrian lanes and damage to pedestrian surfaces. So that this becomes an obstacle for pedestrian users and reduces the assessment results. The surface characteristics of pedestrian paths significantly impact disabled users, especially wheelchair users, affecting their overall comfort, safety, and mobility (Darko et al., 2022; Pearlman et al., 2013)

Third, related to the width of the pedestrian, the factor that affects the difference in value is the width of the pedestrian body that is different. Some sub-segments have an average width of between 1.5 – 2 m, while some other sub-segments are found to be 2.1 – 3 m wide. However, the value of the pedestrian width is still appropriate and meets the existing standards, where the minimum width for pedestrians is 1.5 meters.

From the score results of each sub-segment, an average value is then made, and an assessment of the segment's quality is obtained, as seen in Table 5. The final results were obtained for Segment 1, which received quality II (High), Segment 2, which received quality I (Very High), Segment 3, which received quality II (High), and Segment 4, which received quality I (Very High).

Table 5. Final assessment results for each segment

Segment	Average score	Category
1	80.46	High Quality (II)
2	81.61	Very High Quality (I)
3	79.31	High Quality (II)
4	85.06	Very High Quality (I)

(Source: Research Data)

Good pedestrian paths are essential for urban planners aiming to enhance walkability and reduce carbon emissions in urban environments. Comfortable and safe pedestrian paths also contribute to improved quality of life. Research shows that pedestrian paths that have adequate facilities, such as seating, good lighting, and accessibility, can improve user comfort (Safira et al., 2023; Wulanningrum, 2021). When pedestrians feel safe and comfortable, they are more likely to choose walking as the primary mode of transportation, leading to a reduction in the use of private vehicles (Kusmalinda et al., 2019). By designing an environment that supports walkability, urban planners can create more efficient areas and reduce the need for motorized vehicle-based transportation (Guo et al., 2023).

In this context, good pedestrian paths not only improve mobility but also reduce congestion and air pollution, which are important factors in reducing carbon emissions (Opeoluwa Oluwanifemi Akomolafe et al., 2024). Additionally, by creating a pedestrian-friendly environment, cities can attract more visitors and increase local economic activity (Sari et al., 2020).

This shift not only reduces greenhouse gas emissions but also promotes a healthier lifestyle, as walking is associated with many health benefits (Jabbari et al., 2021). The psychological aspects of walkability cannot be overlooked. Research shows that

pedestrian-friendly environments can reduce stress and enhance the overall quality of life for residents (Nissanka & Jayasinghe, 2023). By designing urban spaces that prioritize pedestrian comfort and safety, planners can create environments that encourage walking, thus leading to a reduction in vehicle use and associated emissions (Yosifof & Fisher-Gewirtzman, 2024)

Recommendation

This evaluation looks at the extent to which pedestrian paths can make accessibility easier for people with disabilities. Referring to the results that have been obtained, it can be concluded that the pedestrian path on Jalan Suroto is very feasible and meets the needs of street space for people with disabilities. The results are considered appropriate and can be used considering that the instrument made refers to the problems experienced by those with disabilities who use wheelchairs, have difficulty walking, and are blind, according to Berret et al. (1998). The L (Low important), M (Medium important), and V (Very important) indicators are used to see how important the presence of these indicators is in the pedestrian for people with disabilities.

Based on the instruments developed, features such as road crossings, surface conditions, and ramp or curb design are very important features and must be owned by each disability group. There are still several sectors that have not been fulfilled and can be evaluated for better improvement. Disabilities, especially for the visually impaired, certainly really need a guide path or guiding block. Berret et al. (1998) categorized the entrance guide path as a very important need. Although there are already guide lanes along the pedestrian, it turns out that other problems arise from the large number of guide lanes that have begun to be damaged (see Figure 3).

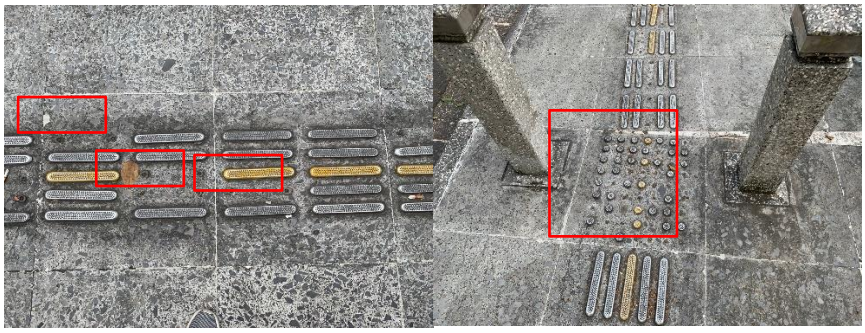

Figure 3. Damaged or missing guidelines

The next problem is that there are still road facilities that interfere with pedestrians, namely electric poles, which reduce the width of pedestrians. Some locations that are obstructed by the pole will be quite disturbing to pedestrians, especially those who use wheelchairs, if they cross paths with foot crossings in the opposite direction. Of course, a situation like this can be considered in future planning, considering that the regulations have been explained regarding the choice of pedestrian design form if a disturbance occurs due to facilities such as bus stops. A picture of the pedestrian condition obstructed by the pole can be seen in Figure 4.

Figure 4. Road facilities such as electric poles that reduce the width of pedestrians

CONCLUSION

Based on the data collected and analyzed, this chapter will provide possible implications, limitations, and recommendations for future research.

Implication

Evaluation of pedestrian design is essential for people with disabilities to ensure inclusivity and accessibility in urban environments (Adi et al., 2024). The study results showed that the condition of the pedestrian path for disability accessibility on Jalan Suroto got good results. This study has divided the pedestrian path into 4 segments. The final results were obtained for segment 1 to receive quality II (High), segment 2 to receive quality I (Very High), segment 3 to receive quality II (High), and segment 4 to receive quality I (Very High). Although the results are very good on average, some indicators lack value. Governments and infrastructure project organizers must ensure that all elements that support accessibility for persons with disabilities, such as guide lanes and adequate lane widths, are maintained and repaired regularly. The difference in quality in sub-segments worked on simultaneously indicates the need for more careful and sustainable planning. By paying attention to these implications, it is hoped that the quality and accessibility of pedestrians can be improved, creating a safer, more comfortable, and inclusive environment for all users. Adequate facilities on pedestrian paths, such as seating, good lighting, and accessibility, can enhance user comfort and encourage them to choose walking as their primary mode of transportation. This can reduce the use of private vehicles, thereby decreasing traffic congestion, air pollution, and carbon emissions. Additionally, a pedestrian-friendly environment can boost local economic activity and support a healthier lifestyle while reducing stress.

Limitation

This research only covers certain segments of Jalan Suroto. The results and findings may not fully represent pedestrian conditions in other areas of the city that have different characteristics and challenges. The data collected comes mostly from field observations and visual assessments, which can be subjective. These limitations can affect the accuracy of the assessment results and data interpretation.

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Developing Teaching Factory Laboratory for Vocational Education: Case Study from Bachelor of Applied Culinary Arts

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Teaching factory,
Vocational education,
culinary arts,
TF-6m model,
ADDIE model,
Industry integration

ABSTRACT

This study aims to develop a Teaching Factory (TEFA) laboratory framework for the Bachelor of Applied Culinary Arts program at Surabaya State University, utilizing the TF-6M Model and the ADDIE Model. The primary objective is to bridge the gap between vocational education and industry needs by creating a realistic learning environment that simulates industrial processes. The research employs a qualitative approach, involving needs analysis through interviews and surveys with industry representatives, faculty, and students. The findings indicate a significant demand for a TEFA laboratory, with 80% of respondents highlighting the necessity for practical skills training. The developed framework consists of six key steps: Receiving Orders, Analyzing Orders, Stating Readiness to Execute Orders, Executing Orders, Conducting Quality Control, and Delivering Orders. Evaluation results demonstrate high satisfaction with the teaching materials and simulations, although improvements in quality control procedures are recommended. This research contributes to enhancing students' job readiness and aligns vocational education with industry standards, showcasing the novelty of integrating practical experiences into the curriculum.

INTRODUCTION

Vocational education plays a crucial role in achieving the Sustainable Development Goals (SDGs), particularly Goal 4, which emphasizes the importance of inclusive and quality education as well as lifelong learning opportunities for all (Saini et al., 2023). In the context of the Fourth Industrial Revolution, vocational education is essential for equipping learners with the relevant skills demanded by industries, including digital competencies, analytical abilities, and strong soft skills (Borrageiro & Mennega, 2023). One of the initiatives to achieve this goal is the development of Teaching Factory (TEFA), which serve as an educational model that integrates theory and practice within real work environments (Casmudi, C., Sugianto, S., & Maulida, 2022).

The TEFA model bridges the gap between education and the workforce by creating a learning environment that simulates real working conditions (Endang & Kuat, 2023). In addition to developing technical skills, TEFA also hones essential management, communication, and collaboration abilities that are vital in the workplace. The presence of TEFA supports the sustainable development agenda by fostering education that is responsive to the ever-evolving demands of the labor market (Filho et al., 2024). Through problem-based learning experiences, students can engage in experimentation, innovation, and continuous decision-making. Furthermore, the development of TEFA in vocational education institutions aligns with the principles of lifelong learning (Thwe & Kálmán, 2024).

At Surabaya State University, the Bachelor of Applied Culinary Arts program within the Vocational Faculty is currently focused on developing the TEFA concept. The primary aim of this TEFA development in the program is to implement a project-based learning model while fostering an entrepreneurial spirit among students. This approach not only provides students with a more contextual and practical learning experience but

also enables them to understand and master the entire industrial process. It is anticipated that this will enhance their readiness to effectively tackle challenges in the workforce.

One of the concepts currently widely used to develop TEFA in vocational education is the TF-6M Model. This model is particularly appealing and frequently implemented due to its ability to integrate various management aspects that are crucial for the operational success and learning outcomes in vocational settings. Its effectiveness can be measured by several previous studies. For instance, Saputro (Saputro, 2024) explored the development of a TEFA learning model based on a Green Campus that supports the SDGs, where the TF-6M Model plays a role in waste management and enhancing student competencies. Similarly, Agus (Agus, 2023) applied the TF-6M Model at VHS 3 Selong to boost student interest and learning outcomes, reporting a 37% increase in interest and a 15.18% improvement in academic performance.

Meanwhile, Utami and Supardi (Utami & Supardi, 2022) found that entrepreneurship education and the TF-6M Model significantly impact the entrepreneurial competencies of students at VHS PGRI Subang, contributing 75.8% to their development. In the context of evaluation, Rukmana et al. (Rukmana et al., 2021) assessed the implementation of the Teaching Factory assistance program at VHS Jakarta Pusat 1, although they did not directly link it to the TF-6M Model. Lastly, Asriati (Asriati, 2019) examined the effectiveness of the TF-6M and 4D Models at VHS 6 Pontianak in the face of the Fourth Industrial Revolution, demonstrating an improvement in entrepreneurial learning outcomes. Overall, these studies affirm the effectiveness of the TF-6M Model in enhancing the competencies and skills of students across various vocational education contexts.

Based on several previous studies, it is evident that the implementation of TEFA is currently more prevalent at the vocational high school level, while research focusing on higher education remains limited. Furthermore, the existing studies primarily concentrate on the aspects of implementation and its impact on student competencies, without delving deeper into the models or frameworks used to develop Teaching Factory laboratories in the culinary field. This highlights the need to explore the comprehensive development process of TEFA in the context of higher vocational education.

Therefore, the primary objective of this study is to demonstrate how the TF-6M Model can be applied in the development of TEFA laboratories within the Bachelor of Applied Culinary Arts program at the Vocational Faculty of Surabaya State University. Through this case study, it is anticipated that deeper insights will be gained regarding the effective development process of TEFA that aligns with industry needs, as well as making a meaningful contribution to the advancement of vocational learning models in Indonesia.

RESEARCH METHOD

This type of research is a development study with a qualitative approach. The aim of this study is to develop a conceptual framework for Teaching Factory laboratories using the ADDIE Model and the TF-6M concept. The ADDIE Model was chosen for its ability to provide a systematic structure for planning, developing, and evaluating curricula or educational programs. The research process follows the five main stages of the ADDIE Model: Analysis, Design, Development, Implementation, and Evaluation.

During the **Analysis stage**, the needs identification and goal setting for the development of the TEFA laboratory are conducted. This phase includes an analysis of industry needs and stakeholder expectations, as well as an assessment of the competencies required in the context of culinary education. Data is collected through interviews with industry representatives, surveys of faculty and students, and relevant literature reviews to ensure a comprehensive understanding of the needs and expectations.

Next, in the **Design stage**, the conceptual framework for the TEFA laboratory is developed based on the analysis results. This design involves creating planning documents that outline the order acceptance process, order analysis, readiness statement for execution, order fulfillment, quality control, and order delivery in accordance with the TF-6M model. The design also considers the integration of project-based learning elements and hands-on practice to ensure relevance and effectiveness in the context of culinary education. The **Development stage** involves creating the necessary materials, modules, and tools to support the implementation of the conceptual framework. A prototype of the TEFA laboratory is developed and initially tested to ensure its alignment with the designed curriculum. This activity ensures that all elements required for the laboratory's operation are ready and functioning properly.

During the **Implementation stage**, the developed conceptual framework is applied in a simulated TEFA laboratory. This activity includes conducting teaching sessions, training, and initial evaluations to assess the effectiveness of the conceptual framework. Implementation is carried out through faculty training and trials with students to test the readiness and feasibility of the designed framework. Finally, in the **Evaluation stage**, an assessment is conducted on the effectiveness and efficiency of the applied conceptual framework. The data analysis techniques used include qualitative analysis of feedback from faculty, students, and industry stakeholders, as well as evaluations of the documents and teaching materials used during the implementation phase. Data is collected through surveys, interviews, and direct observations. This evaluation aims to refine and enhance the conceptual framework based on the feedback received and the needs identified during the implementation process.

RESULTS AND DISCUSSION

Analysis

The analysis results indicate a significant need for a Teaching Factory laboratory within the Bachelor of Applied Culinary Arts program. Data collected from interviews with industry representatives, as well as surveys of faculty and students, reveal a gap between the skills possessed by students and the requirements of the industry. Out of a total of 50 respondents, 80% expressed the necessity for a laboratory that can realistically simulate industrial processes.

Table 1. Presents the Survey Results Regarding the Need for A Laboratory.

Aspect	Percentage of Respondents (%)
Practical Skills	80
Job Readiness	70
Industry Integration	75
Training Quality	85

Design

The designed conceptual framework consists of six main steps in accordance with the TF-6M Model. Each step is detailed in the planning documents as follows:

a. **Receiving Orders:** This process involves registering orders and understanding the needs of industry clients. Registration forms and order analysis templates have been developed.
b. **Analyzing Orders:** This stage includes a thorough evaluation of the received orders, encompassing product specifications and completion timelines. Order analysis documents are prepared to include key parameters.
c. **Stating Readiness to Execute Orders:** This involves a declaration of the team's and facilities' readiness. Readiness documents and verification checklists are prepared.
d. **Executing Orders:** This is the production or fulfillment process that adheres to established standards. Standard Operating Procedures (SOPs) are developed.
e. **Conducting Quality Control:** This stage includes quality checks to ensure that the products meet the established standards. Quality control guidelines are created.
f. **Delivering Orders:** The delivery process encompasses documentation and feedback. Delivery forms and customer satisfaction surveys are designed.

Development

In the development stage, a prototype of the Teaching Factory laboratory and teaching materials are produced. The details of the development outcomes are as follows:

a. **Teaching Materials:** Modules and training materials are created for each step in the TF-6M Model.
b. **Laboratory Prototype:** Tools and equipment for simulating industrial processes are prepared, including workstations and simulation software.

Table 2. Details of Developed Tools and Equipment

Tool/Equipment	Description
Workstation	Contains production equipment
Simulation Software	Order management simulation
Training Modules	Materials for each stage of TF-6M

Implementation

The implementation is carried out through simulations in the laboratory. Training for faculty and students is conducted using the developed conceptual framework. Initial evaluations indicate positive results, with participant satisfaction levels as follows:

Table 3. Participant Satisfaction Evaluation Results

Evaluation Aspect	Average Score (1-5)
Quality of Teaching Materials	4.5
Relevance of Simulation	4.7
Facility Readiness	4.6
Faculty Training	4.8

Evaluation

The evaluation is conducted to assess the effectiveness of the conceptual framework. Feedback data indicates that this framework effectively meets the needs of both students and the industry. However, several areas require improvement, including enhancements to the quality control procedures and adjustments to the order analysis documents.

Table 4. Feedback Analysis Results

Feedback Aspect	Identified Issues	Proposed Solutions
Quality Control Procedures	Lack of detail	Addition of guidelines and checklists
Order Analysis Documents	Insufficient specificity	Revision of format and parameters

The research findings indicate that the application of the TF-6M Model in the development of the Teaching Factory laboratory provides a clear structure for industry-based learning processes. The TF-6M Model, which includes steps such as Receiving Orders, Analyzing Orders, Stating Readiness to Execute Orders, Executing Orders, Conducting Quality Control, and Delivering Orders, ensures that every aspect of the production process is systematically addressed. The implementation of this model aligns with previous findings that structured models can enhance teaching effectiveness by integrating practical industry elements into the educational curriculum.

The results from each stage of the research indicate that the developed conceptual framework is effective in meeting the needs of both industry and education. This aligns with the findings of Anwar et al. (Anwar et al., 2023), which suggest that integrating industry practices into vocational education curricula can enhance students' job readiness. Evaluations from the simulations and participant feedback demonstrate high satisfaction with the teaching materials and the relevance of the simulations, supporting the assertion that practical experiences related to the industry are crucial for effective learning (O'Neill & Short, 2023).

However, several aspects require improvement, such as the quality control procedures and the order analysis documents. Previous research has shown that well-defined quality control procedures are essential to ensure that production outcomes meet the necessary quality standards (Aggarwal et al., 2019). Therefore, adding guidelines and checklists for quality control can help enhance accuracy and consistency in the laboratory's production processes. Additionally, revising the order analysis documents can improve the clarity of specifications and parameters, which is key to avoiding errors and ensuring alignment between industry demands and production outcomes.

CONCLUSION

This research successfully developed a conceptual framework for the Teaching Factory laboratory in the Bachelor of Applied Culinary Arts program using the TF-6M Model and the ADDIE Model. This framework effectively organizes industry-based learning, encompassing steps from order reception to order delivery. Evaluation results indicate high satisfaction with the teaching materials and the relevance of the simulations, although improvements are needed in the quality control procedures and order analysis

documents to enhance consistency and effectiveness. Overall, the combination of the TF-6M Model and the ADDIE Model has proven to be an effective method for developing a Teaching Factory laboratory that meets industry demands, thereby improving students' job readiness in the culinary field.

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