

The Association Rule of Corn Disease Symptoms by Using Frequent Pattern Growth and Random Forest

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Abstract—Despite proper soil health management, pests and diseases control is also an important task in corn farming for improving both the quality and the quantity of the crops production. One way to address this challenge is to identify the emerging symptoms accurately to help define the appropriate solution. Downy, Leaf Blight, Rot midrib, Rot Stem, Leaf Rust, Burnt, Dwarf, Leaf spot are among the common symptoms on corn crops. Failure to identify these symptoms in the early stage could result adverse effects on the corn crops and reduce the production in the long run. This study therefore aims to classify corn disease symptoms to know the real disease. In this study, Decision trees and Frequent Pattern Growth (FP Growth) are employed. Analysis from the data indicated accuracy values of decision tree J4.5 (ID3) of 95%, J.48 of 96% and Random Forest of 95%. While for the relation pattern with 9 attributes and 2 classes, obtained the most often arise rule is the mycelium symptom or cotton with the leaves color turning red / brown / ash / chlorotic with accuracy of 92%.

Keywords—frequent pattern growth; decision tree; random forest; corn disease symptoms

I. INTRODUCTION

Corn is one of the leading agricultural products in Madura in addition to rice, tobacco and nuts. Local corn varieties are still the main choice for farmers where 90 percent of farmers in Madura still use local corn varieties. The problem is the cultivation still lack optimal. In conjunction with increasing food crop production, corn has important role. But in its management there are obstacles including pests and diseases. The diseases that often attack corn include Downy, Leaf Spot, Rot midrib, Rot Rod, Leaf Rust, Burnt, Dwarf, Leaf Spots [1]. If the diseases are not controlled, the corn production reduced. The steps to control it are by selecting seeds or varieties and pests right handling. One of the ways to find out the corn attack pattern is to look for patterns of disease relations by using association rules [2]. By knowing the interrelationship between diseases can be known the handling priority so the expected operational costs not too high. Association Rule is a procedure in Market Basket Analysis to find knowledge in the relationships form between items in a dataset and display them in the patterns form that explains the relationship between variables or attributes [3]. The Association Rule Method has several methods that can be used including the Apriori method [4], decision tree [5], Frequent Pattern Tree [6], Frequent

Pattern Growth [7], Weighted Tree and many more [8]. This study used Decision Tree J.48 which is the development of Decision Tree J.45 algorithm.

II. LITERATURES

A. Corn disease

Corn disease is diseases that attack the corn plants, can be explained, among others are:

1) Downy mildew (*Peronosclerospora maydis*)

The disease symptoms occur on the leaves surface of white to yellowish followed by chlorotic lines and another characteristic is that in the morning at the leaf bottom there is white velvet layer. Downy mildew on corn plants causes extended systemic symptoms throughout the plant and cause local symptoms. Plants infected with downy mildew at young age usually do not form fruit, but if the infection in older plants they still form fruit but generally with stunted growth [9].

Control can be done by using downy mildew resistant varieties, such as Srikandi, Lamuru, and Gumarang. In addition, simultaneous planting can be carried out and the corn free period at least two weeks to one month in each year. If infected it can be eradicated or totally destroyed. For prevention can use metallaixill fungicide on plant seeds with a dose of 0.7 grams of active ingredient in each kg of seed.

2) Leaf spots (*Bipolaris maydis* Syn)

This disease symptoms occur when yellowish or reddish-brown leaves appear. When the corn seed is exposed to this spot can wither or die within 3-4 weeks. If cobs infected will cause the seeds to break and rot, even the cob can fall. This disease infection can be carried by the wind or raindrops and can cause the first infection in corn plants. Control can use leaf resistant varieties, such as Bima 1, Sukmaraga, and Palakka. If you see plants that have been infected, they must be eradicated immediately. Fungicides can also be carried out with the active ingredients of mancozeb and carbendazim [10].

3) Leaf Blight (*Rhizoctonia solani*)

This disease symptoms occur when oval-shaped spots appear and the spots are elongated and develop into necrotic and called blight. Spots are grayish green or brown and appear

early on the lower leaves then develop towards the upper leaves. Severe infections can cause plants to die quickly or dry out and the fungus does not infect the cob or klobot.

Control can use leaf blight resistant varieties, such as Bisma, Pioneer 2 and 14, and Semar 2 and 5. If visible plants that have been infected must be eradicated immediately. It can also be done using *Trichoderma viride* antagonist fungi and giving fungicides with active ingredients of mankozeb and dithiocarbamate [11].

4) Leaf rust (*Puccinia polysora*)

Symptoms of this disease occur when small patches appear round to oval on the surface of corn leaves at the top and bottom. These patches produce uredospores that are round or oval and play an important role as a source of inoculum in infecting other corn plants and their distribution through the wind. Rust disease can occur in the lowlands to high and the infection develops well in the rainy season or dry season.

Control can be done by using leaf rust resistant varieties such as Lamuru, Sukmaraga, and Semar 10. If visible plants that have been infected must be eradicated immediately. Can also be done by giving fungicides with benomil active ingredient [12].

5) Stem Rot (*Fusarium sp.*)

This disease symptoms generally occur after the flowering phase. The base of infected stem changes color from green to brown, the inside decomposes, so it is easy to fall, the outer skin is thin. At the base of the infected stem shows pink, brownish brown or brown color. This disease can be spread by wind, rain water, and insects.

Control can be done by using stem rot resistant varieties, such as BISI-1, Surya, CPI-2, and Pioneer-8. In addition it can be done crop rotation, balanced fertilization, avoid giving high N and low K, and good drainage to prevent attacks. Biological control can also be carried out with *Trichoderma sp* antagonists [13].

B. Data Mining

Data mining is process that uses statistical techniques, mathematics, artificial intelligence, and machine learning to extract and identify useful information and related knowledge from various databases. Data mining is process that employs one or more computer learning techniques to analyze and extract knowledge or knowledge automatically [3].

1) Decision tree

One method in Data Mining is Decision Tree, is one of the classification methods on Machine Learning. Decision Tree is a classification method that uses a tree structure, where each node represents attribute, and the branch represents value of attribute, while the leaf is used to represent the class. Classification is the process of finding a collection of patterns or functions that describe and separate data classes from one another, so that they can be used to predict data that does not have particular data class [14].

Association rule is pattern of attribute relationships that influence each other. The need to know this pattern is to

determine the attributes priority in decision tree. The attribute table for disease symptoms is shown in Table 1.

TABLE 1. CORN DISEASE SYMPTOMS

TID	Attribute of corn diseases symptoms
Land 1	<i>a,c,e,f,m,p</i>
Land 2	<i>a,c,d,e,f,m,p</i>
Land 3	<i>a,b,c,e,f,g,m</i>
Land 4	<i>b,c,f,i</i>
Land 5	<i>b,c,e,n,p</i>
Land 6	<i>k,l</i>

Attribute control data can be described in binary format, where each row of land corresponds to symptom item and each column corresponds to attribute control. An item can be treated as binary variable worth 1 (y) if the item is in transaction and 0 if the opposite.

Itemset $I = \{i_1, i_2, \dots, i_d\}$ is the set of all items in market basket data and $T = \{t_1, t_2, \dots, t_N\}$ is the set of all transactions. Each t_i transaction contains a subitemset of I . In the association analysis the collection of one or more items is called itemset. If the itemset contains k items, it is called k -itemset. Null sets are itemset that do not contain items. Transaction width is defined as the number of items in the transaction. Example itemset: $\{i_1, i_2, i_3\}$ [15].

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The support count (σ) is the frequency of the appearance of certain itemsets in the transaction. Mathematically, it can be stated by:

$$\sigma(X) = |\{t_i \mid X \subseteq t_i, t_i \in T\}| \quad (1)$$

with:

X = itemset

t_i = transaction i^{th}

T = transaction set

$|\cdot|$ = number of elements in a set

Example: $\sigma(\{i_1, i_2, i_3\}) = 2$

Association Rule is implication expression of $X \rightarrow Y$ form, where X and Y are disjoint itemsets, $X \cap Y = \emptyset$. The

association rule strength can be measured by the value of support and confidence. Support determines how often the rule appears in the data, while confidence determines how often items Y appear with X in the same transaction. Mathematically can be stated by:

$$\text{Support, } s(X \rightarrow Y) = \frac{\sigma(X \cup Y)}{N} \quad (2)$$

$$\text{Confidence, } c(X \rightarrow Y) = \frac{\sigma(X \cup Y)}{\sigma(X)} \quad (3)$$

with notation :

X, Y = itemset

σ = support count

N = total transaction amount

Example of support value:

$$s(i_1, i_3 \rightarrow i_4) = \frac{\sigma(i_1, i_3, i_4)}{N} = \frac{2}{5} = 0.4$$

Example of confidence value:

$$c(i_1, i_3 \rightarrow i_4) = \frac{\sigma(i_1, i_3, i_4)}{\sigma(i_1, i_3)} = \frac{2}{3} = 0.67$$

Association rules exploration can be expressed as if there is set of T transactions, how to find all the rules that have support \geq minsup and confidence \geq minconf, where minsup and minconf are related to the limits of support and confidence values [16].

2) Decision Tree J.48

The algorithm J.48 is the development of conventional decision tree induction algorithm which is very important, namely ID3. The algorithm which is the development of ID3 can classify data with decision tree methods that have advantage able to process numerical and discrete data, can handle missing attribute values, produce rules that are easily interpreted, and the fastest among algorithms that use main memory on the computer [17]. In the application of several cases of classification techniques, this algorithm able to produce better performance.

3) Frequent Pattern Growth

FP-growth algorithm is very efficient algorithm in finding frequent itemset in data set by generating prefix-tree structure or called FP-tree. Frequent Pattern Growth (FP-growth) is alternative algorithm that can be used to determine the most frequently occurring data sets (data itemset) in data set. FP-growth algorithm uses data structure called FP-tree (Frequent Pattern Tree) in conducting frequent itemset searches [18].

As the name implies, FP-tree is tree structure where each branch contains frequent itemset information and each node stores item information and frequency. The parent and child sequence of this tree is determined by the frequency of each item. Items with greater frequency will be the parent for items with smaller frequency. Likewise the opposite item with smaller frequency will be child for larger item. Thus, the leaf

from this tree is the item with the smallest frequency. This algorithm does not do candidate generation in the frequent itemset search process so that it can reduce database scans repeatedly in the mining process and can run faster [19].

FP-tree has header table that contains item information and frequency and has pointer to the node in the tree. The items list in this table is arranged based on the frequency, starting with items with the largest frequency then followed by items with smaller frequencies and so on. When compared with the Apriori algorithm and the variants or techniques of candidate generation, which requires several checks on the database, FP-growth only requires two checks on the database. The first check calculates the frequency of each item and then puts it in the table. Then proceed with second check that will enter the frequency information of each item into the FP-tree [20].

After the header table and FP-tree are created, frequent itemset search is only carried out through this structure, so that until this stage the examination of the database is no longer needed. The next level of frequent itemset is obtained by creating a FP-tree conditional with the FP-growth algorithm. This algorithm works recursively in making FP-tree conditionals. In the FP-growth algorithm, FP-tree tracing is mandatory step to obtain FP-tree conditionals. To make FP-tree conditionals are needed twice FP-tree search. As result, most of the time used by this algorithm is spent doing FP-tree search.

Therefore to reduce search time can be achieved with modification by using an additional data structure in the array form so the search process in FP-tree can be reduced [21]. FP-tree search is only done once because the information needed to make FP-tree conditionals is available in array. This FP-growth algorithm modification produces a new algorithm called FP-growth algorithm.

4) Random forest

Random forest (RF) is algorithm used in the classification of large amounts of data. Random forest classification is done through the trees merging by conducting training on the sample data owned. The trees use that increasingly affect the accuracy that will be obtained is better. Determination of classification by random forest is taken based on the results of the voting of tree formed. Winners of the tree formed are determined by the most votes. Tree construction on random forest until it reaches maximum size of the data tree. However, the random forest tree construction is not pruned which is method to reduce space complexity. Development is carried out by applying random feature selection method to minimize errors. Tree formation with sample data using variables taken randomly and run classification on all the trees that are formed [22].

C. Level of accuracy, sensitivity and specificity

The accuracy calculation as shown in the formula 4,5,6,7 [23].

$$\text{Accuracy} = (TP + TN) / (TP + TN + FP + FN) \quad (4)$$

$$\text{Sensitivity / Recall} = TP / (TP + FN) \quad (5)$$

$$\text{Specificity} = TN / (TN + FP) \quad (6)$$

$$\text{Precision Rate} = TP / (TP + FP) \quad (7)$$

With description of TP (true positive) = record number of corn disease symptom classified as the corn diseases cause, TN (true negative) = records number of non bacteria corn disease classified as not corn disease, FN (false negative) = records number of corn disease classified as non-corn disease and FP (false positive) = records number of not corn disease classified as corn disease [24].

III. METODOLOGY

The methodology in this study can be described as shown in figure 1.

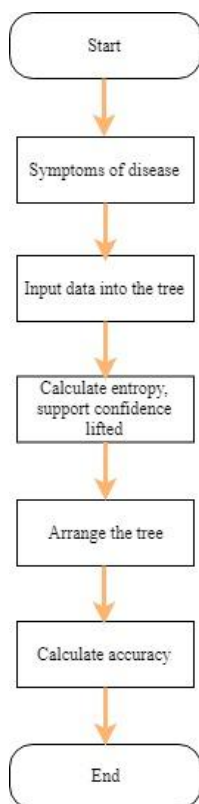


Fig. 1. Methodology

In this study, the experimental data processing is done by using 3 algorithms, namely Decision tree C4.5, Decision Tree J48, Random Forest and FP Growth.

IV. DISCUSSION

This study uses 100 records consisting of 15 attributes and 6 classes that are used to form decision tree. The attributes used include symptoms of small / round spots on leaves of leaf color (red / brown / ash) chlorotic dry / wilted / dwarf, thin bark rotten midrib (red, ash) mycelium (cotton) klobot infection sticking, rotten brown cob of corn seeds, Sclerotium fungus (spore) with 5 classes is action that needs to be done in connection with the disease, namely fungicide-eradication-variety, variety-drainage-fungicide-rotation, fungicide, fertilization-rotation, fungicide-eradication-rotation, and variety-annihilation -fungicide.

TABLE II. TABLE SYMPTOMS OF CORN PLANT DISEASE

Name of Corn Disease	Action taken			
Leaf blight	Selection of varieties	Eradication	Fungicide	-
Stem rot	Selection of varieties	Idrainase	Fungicide	Crop rotation
Downy	Selection of varieties	Eradication	Fungicide	Crop rotation
Rotten Cob_fusarium	Fungicide	-	-	-
Rotten cob_diplodia	Fungicide	-	-	-
Rotten cob_gibberella	Fertilization	Crop rotation	-	-
Stem rot	Fungicide	-	-	-
Leaf rust	Selection of varieties	Destruction	Fungicide	-
Mozaic virus	Selection of varieties	Eradication	Fungicide	Crop rotation

From the fifteen attributes using the decision tree algorithm J4.5 or ID3, Correctly Classified Instances 96 (96%), Incorrectly Classified Instances 4 (4%), Kappa statistics 0.9492, Mean absolute error 0.0247, Root mean squared error 0.1112, Relative absolute error 9.3885%, Root relative squared error 30.6874% of the Total Number of Instances 100. While the decision tree results are formed using Classifier J48, the tree structure and accuracy values are obtained. The second result uses Decision Tree J48, the following tree structure is obtained

```

Round spot <= 0
| small round spot on leaf <= 0
| | mycelium (cotton) <= 6
| | | presence of pest<= 0
| | | | klobot infection(sticking) <= 0: fungicide--- (22.0)
| | | | infeksi_klobot(sticking) > 0
| | | | leaf color (red/brown/grey/chlorotik) <= 4: rotation fertilization-- (8.0)
| | | | leaf color (red/brown/grey/chlorotik) > 4: fungicide--- (11.0/1.0)
| | | presence of pest> 0: variety-eradication -fungicide-rotation(23.0/2.0)
| | mycelium (cotton) > 6: variety-drainage-fungicide-rotation(15.0/1.0)
| small round sport on leaf > 0: variety-eradication-fungicide- (11.0)
Round spot> 0: variety-eradication-fungicide- (10.0)
  
```

with Confusion Matrix for each class that shows the best treatment to be done is shown as follows

a b c d e f <-- classified as

11 0 1 0 0 0 | a = variety-eradication-fungicide-

0 14 0 0 0 0 | b = variety-drainage-fungicide-rotation
 0 2 31 0 1 0 | c = fungicide---
 0 0 0 8 1 0 | d = fertilization-rotation--
 0 0 0 0 21 0 | e = variety-eradication-fungicide-rotation
 0 0 0 0 0 10 | f = variety-eradication-fungicide-

Accuracy is calculated by calculating accuracy, sensitivity and specificity

TABLE III. ACCURACY CALCULATION

TP rate	FP rate	Precision	Recall	F-Measure	ROC Area	Class
0.6368	-	1.0000	0.6368	0.6646	0.6868	varieties-eradication-fungicide
1.0000	0.012	0.6479	1.0000	0.6708	0.6903	varieties-drainage-fungicide-rotation
0.6535	0.015	0.0674	0.6535	0.6632	0.6813	fungicide
0.6174	-	1.0000	0.6174	0.6535	0.6896	fertilization-rotation
1.0000	0.025	0.6340	1.0000	0.6632	0.0688	varieties-eradication-fungicide-rotation
1.0000	-	1.0000	1.0000	1.0000	1.0000	varieties-removal-fungicide

Furthermore, by using the Decision Tree J.48, the result of Correctly Classified Instances 95 (95%) Incorrectly Classified Instances 5 (5%) Kappa statistics 0.9367, Mean absolute error 0.0296, Root mean squared error 0.1327, Relative absolute error 11.2045%, Root relative squared error 36.578%, Total Number of Instances 100.

And trees formed by using J.48 were then processed to obtain item relations from corn disease symptoms by using 9 attributes including 'small / round spots on the leaves,' leaves (red / brown / ash / chlorotic), 'dry / wilted / dwarf, skin thin stems, 'midribs' (red / gray), 'mycelium (cotton),' klobot infection 'sticks,' stinking infections 'brown corn seeds,' sclerotium fungi (spores) and 2 classes namely fungicide-drainage-rotation-eradication varieties - fertilization and fungicides. Using 50 training data obtained Correctly Classified Instances 46 (92%), Incorrectly Classified Instances 4 (8%), Kappa statistics 0.8983, Mean absolute error 0.1648, Root mean squared error 0.2314, Relative absolute error 62.4124%, Root relative squared error 63.8584 %, Total Number of Instances 100, the result is a rule as shown in the following explanation.

FP Growth found 13 rules (displaying top 10)

- [mycelium (cotton) = y]: 12 ==> [Leaf color (red / brown / ash / chlorotic) = y]: 12 <conf: (1)> elevator: (1.61) lev: (0.09) conv: (4.56)
- [mycelium (cotton) = y]: 12 ==> [mushroom sclerotium (spore) = y]: 12 <conf: (1)> lift: (2) lev: (0.12) conv: (6)
- [foul cobs infection = y, mycelium (cotton) = y]: 9 ==> [leaf color (red / brown / ash / chlorotic) = y]: 9 <conf: (1)> elevator: (1.61) lev: (0.07) conv: (3.42)
- [mycelium (cotton) = y]: 12 ==> [leaf color (red / brown / ash / chlorotic) = y, sclerotium (spore) = y]: 12 <conf: (1)> elevator: (2.5) lev: (0.14) conv: (7.2)
- [color_ leaves (red / brown / ash / chlorotic) = y, mycelium (cotton) = y]: 12 ==> [sclerotium (spore) = y]: 12 <conf: (1)> lift: (2) lev: (0.12) conv: (6)
- [fungus sclerotium (spore) = y, mycelium (cotton) = y]: 12 ==> [Warna_daun (red / brown / ash / chlorotic) = y]: 12 <conf: (1)> elevator: (1.61) lev: (0.09) conv: (4.56)
- [foul cobs infection = y, mycelium (cotton) = y]: 9 ==> [sclerotium fungus (spore) = y]: 9 <conf: (1)> elevator: (2) lev: (0.09) conv: (4.5)
- [rotten cobs infection = y, mycelium (cotton) = y]: 9 ==> [leaf color (red / brown / ash / chlorotic) = y, sclerotium (spore) = y]: 9 <conf: (1)> elevator: (2.5) lev: (0.11) conv: (5.4)
- [color_daun (red / brown / ash / chlorotic) = y, foul cobs infection = y, mycelium (cotton) = y]: 9 ==> [sclerotium fungus (spore) = y]: 9 <conf: (1)> elevator: (2) lev: (0.09) conv: (4.5)
- [foul cobs infection = y, sclerotium fungus (spore) = y, mycelium (cotton) = y]: 9 ==> [leaf color (red / brown / ash / chlorotic) = y]: 9 <conf: (1)> elevator: (1.61) lev: (0.07) conv: (3.42)

V. CONCLUSION

From the analysis and testing results, it can be concluded that by using algorithm of the decision tree J4.5 or ID3 obtained 96 Correctly Classified Instances, accuracy results of Decision Tree J.48 shows 95% Correctly Classified Instances, and the Random Forest Classified Instances 95% with the best rule result of FPGrowth on [mycelium (cotton) = y]: 12 ==> [Leaf color (red / brown / ash / chlorotic) = y]: 12 <conf: (1)> elevator: (1.61) lev: (0.09) conv: (4.56)

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AUTONOMOUS QUADCOPTER STABILITY WITH PID CONTROL

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Abstract— *Unmanned Aerial Vehicle (UAV) has many uses, including aerial photography, aerial mapping and monitoring activities. Quadcopter is a type of UAV that uses four rotors. The speed of each rotor has a considerable influence on the movement. The quadcopter movement can be done in this research, namely the process of arming, taking off, hover, and landing on decisions made by the system (autonomous). How the quadcopter achieves a balance in its movement to be stable and responsive requires a method. One method that is suitable for processing stability is the method (PID). The PID method has three main parameters, namely Proportional (Kp), Integral (Ki), Derivatives (Kd), with the determination of the constant through the trial and error process to obtain the optimal stability value as the purpose of this study. But the load of the quadcopter and the wind tightness around it is very influential to get the quadcopter movement to survive in stable conditions. Through a series of experimental processes carried out to produce the best constant values, at $K_p = 1.3$, $K_i = 0.04$, and $K_d = 18$, where the quadcopter is able to survive for 20 sec at the same relative point from the time of departure. The addition of GPS sensors in advanced research will be able to make this quadcopter move stable with the monitored position.*

Keywords—UAV; Quadcopter; PID; Autonomous

I. INTRODUCTION

Quadcopter / quadrotor is one type of UAV (Unmanned Aerial Vehicle) which has a manual or automatic control system. The development of this UAV has been used in various aspects. For example in agriculture. The Center for Agricultural Land Resources Research and Development began developing unmanned aircraft with the aim of analyzing the condition of plants / vegetation or agricultural land using VNIR, SWIR, thermal, radar or SAR bands [1]. Another example in the military field, the reconnaissance process in hard-to-reach areas is the background of the development of drones / UAVs by the National Aeronautics and Space Agency (LAPAN) [2].

Aerial footage Photography, Aerial footage Videography, Aerial mapping including activities that require drones / UAVs in the implementation. In addition to the skills of the user users, the stability and the surrounding natural conditions also have a considerable influence. A good drone is a drone / UAV that can maintain stability from outside interference, for example wind

speed and frequency interference. Quadcopter is one type of UAV with four rotor drives. Each rotating rotor has a lift force and has the same distance to the center of gravity. This type of quadcopter is one type of drone that is quite easy to maneuver.

The method used to be able to adjust the rotational speed of a quadcopter motor is the PID method. The method that uses proportional (Kp), integral (Ki), derivative (Kd) elements aims to accelerate the reaction of a system, eliminate offsets and produce large initial changes. Literatur Review

Researchers of Gembong ES examined the height control on a quadcopter. In controlling the quadcopter, the PID method was used to obtain stability. Researchers are more likely to do testing in the form of simulations [3]. Likewise with Panca AK researchers, the method used is the Fuzzy PID in stabilizing the height of the quadcopter. This research only focuses on pitch and roll angle movements [4]. Guneshwor Singh menjelaskan tentang navigasi otomatis pada quadcopter.

There are two types of propellers in the test. Propellers with a 10 inch size and a pitch of 4.5 can produce a greater total thrust than the use of an 8 inch size propeller with the same pitch size. This also affects flight time which tends to be longer when using a 10 inch propeller [5].

Analysis of the stability of diagonal motion has been carried out by Salmaa. The analysis includes the combination of lateral motion and longitudinal motion in a quadcopter. Based on the analysis, the stability of the diagonal motion model is obtained that all diagonal motion models are unstable. Therefore PID control is needed by determining the gain of Kp, Ki, and Kd [6].

Determination of the combination of PID constants is very influential on the control of stability of the quadcopter. The PID constant generated from the research conducted by Wili Kumara is $K_p = 40$, $K_i = 40$, $K_d = 60$ for roll motion while $K_p = 40$, $K_i = 60$, and $K_i = 60$ for pitch movement. However, the value of this constant has a fluctuation of 1° to (-5°) slope [7].

II. PID METHOD

The PID method is a control system consisting of three types of controllers, namely Proportional, Integral and

Derivative controllers. PID controller is one of the control methods that is often used in industrial control systems [8].

A. Proportional Controller

The proportional controller has an output proportional to the magnitude of the error signal (the difference between the desired amount and the actual price). More simply it can be said that proportional controller output is a multiplication between proportional constants with input. Changes to the input signal will immediately cause the system to directly change its output by its constants.

B. Integral Controller

The integral controller functions to produce a system response that has a steady state error (zero steady state error). If a plant does not have an integrator element, the proportional controller will not be able to guarantee the system output with a zero steady state error. The use of an integral controller, the system response can be corrected, which has a zero steady state error.

An integral controller has characteristics as well as an integral. The controller output is greatly affected by changes that are proportional to the error value. If the error signal does not change, the output will maintain the state as before the input changes.

C. Derivative Controller

Intuitively, the oscillating system response is caused by several things. The dynamic process of a plant causes the response of a plant to not change immediately with a change in the control signal, but requires processing time. This time will make the control system experience delays to correct errors. This requires a controller that can predict errors from a system.

Derivative controllers are generally used to speed up the initial response of a system, but do not minimize errors in the steady state. Derivative controller work is only effective in a narrow scope, namely in the transition period. Therefore the derivative controller is never used without any other controller of a system [8].

III. BLOCK DIAGRAM SYSTEM

The block diagram in Fig. 1 is a system diagram consisting of several inputs which include the MPY-6050 type GY module in which there is an MPU-6050 sensor. Input in the form of slope data (gyrometer) and acceleration (accelerometer) becomes a reference for quadcopter balancing movements. The output of the system in the form of the speed value converted into a voltage value by ESC will drive a brushless motor that amounts to four. Brushless motor speed will be fully controlled using the PID method calculation. The ESC specification and brushless motor are adjusted to the load of the quadcopter.

Input in the form of height sensor / wind pressure is a barometer and receiver from 2.4GHz radio control in the process on a different microcontroller. This section is as a medium for information on the height of the quadcopter when the quadcopter airs. Quadcopter communication with ground

station uses a bluetooth / wireless network module. The ground station receives altitude data from bluetooth to be able to control the 2.4Ghz transmitter radio control and provide information on the current mode status and height data on the personal computer.

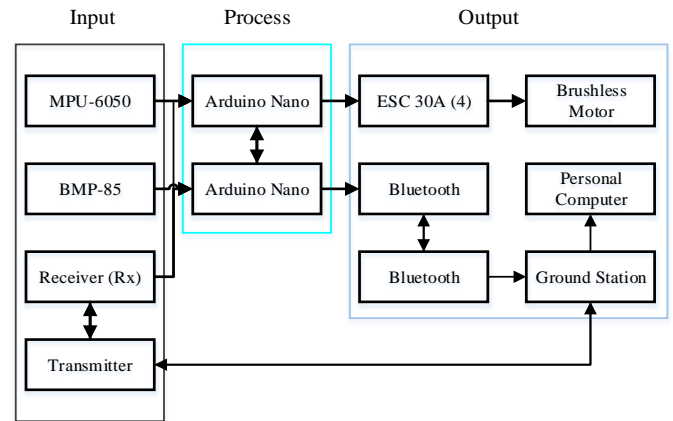


Fig. 1. Block Diagram System

IV. FLOWCHART

A. General Flowchart Autonomous System

In Fig. 2 and Fig. 3 are general autonomous system flowcharts. Overall testing is done if the constant K_p , K_i , K_d is found to be optimal. This process is the whole process of moving the system on a quadcopter.

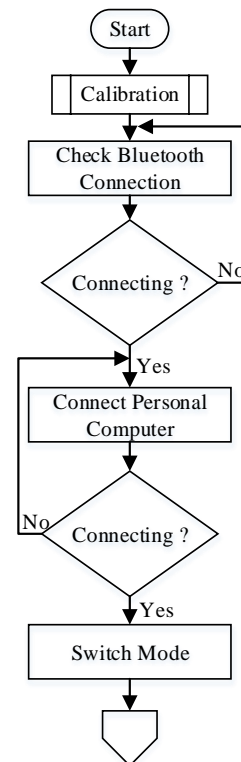


Fig. 2. General flowchart of autonomous systems part 1

Two bluetooth (master / slave) auto-pairing, both have ID identifiers, so bluetooth will be connected to bluetooth whose identification ID has been aligned. After the Bluetooth connection process is complete, the next step is to connect the personal computer to the system using a USB cable. Users can choose to use autonomous mode (automatic) or manual mode. When using autonomous mode, the system will run automatically according to the system design that has been made. The command to turn on the brushless motor is done by using a radio control transmitter. In the aeromodeling field, the process is often known as the Arming process. Then Take off is a quadcopter process to take off. Take off is done until it reaches a height of five meters. If the height has reached ten meters, the quadcopter will maintain height and stability for 30 seconds. Then the quadcopter will land / land slowly until it reaches the surface. But if the user uses manual mode. The manual program will be activated, all control systems are carried out manually by the user with a radio control device. Flowchart PID.

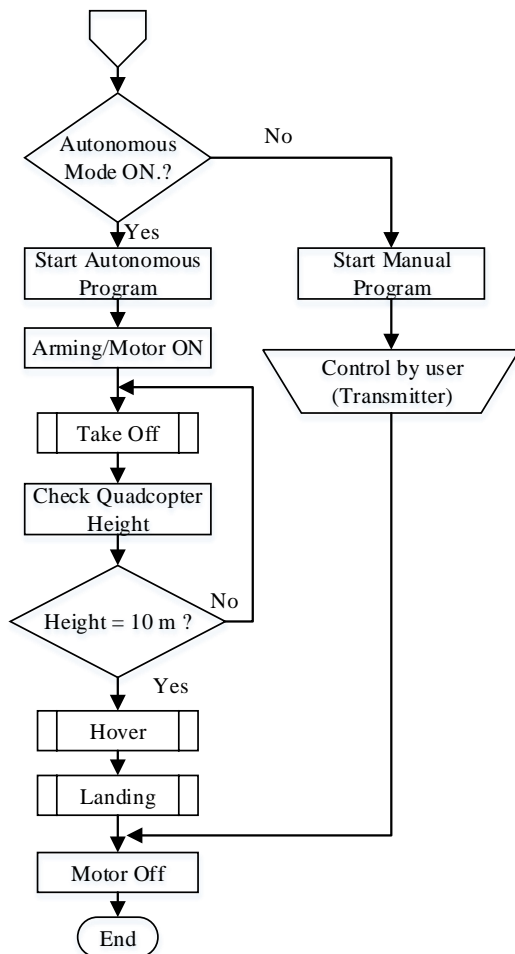


Fig. 3. General flowchart of autonomous systems part 2

In Fig. 4 is a flowchart from the PID method. The PID method is used to maintain the stability of the quadcopter when moving. This method requires the main constants, K_p , K_i , K_d and Set point. The constant will be used to obtain an optimal

system response. Determination of the value of K_p , K_i and K_d based on experiments by adjusting specifications on hardware. Starting with the reading of the gyro quadcopter value on the pitch, roll and yaw axis. The gyro data will be used as input for the calculation of the PID method. The output from the PID calculation will produce a PWM value for each brushless motor. The process will repeat the process until the error value is 0. The PID calculation is applied to the manual mode or autonomous mode.

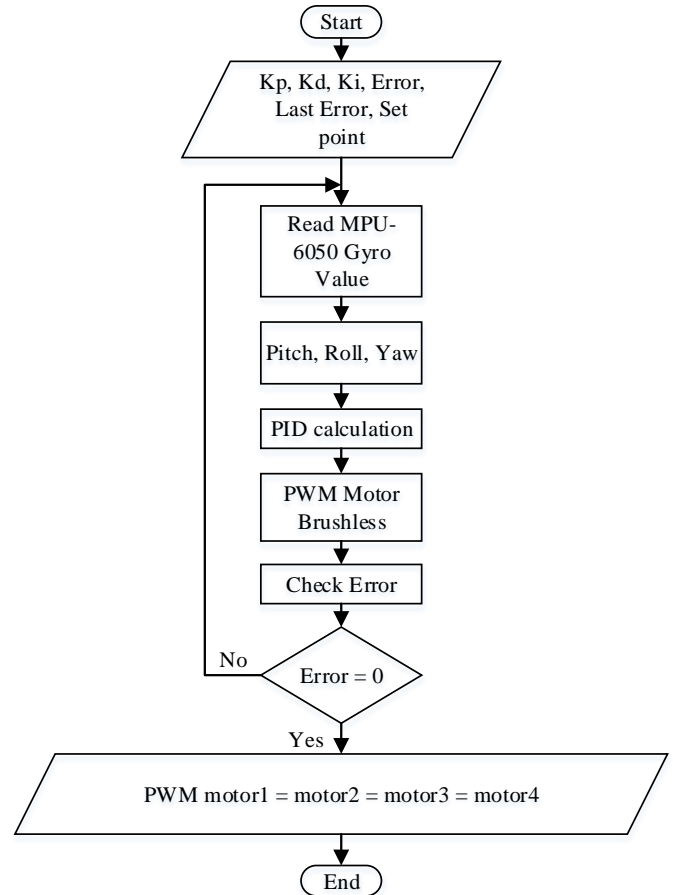


Fig. 4. Flowchart PID

V. TESTING

A. Bluetooth Distance Testing

Testing is done in the open. This test aims to determine the range of the second Bluetooth communication. Because bluetooth communication is very important, the installation of the bluetooth module and the direction of the antenna on the bluetooth module must be considered very carefully. shown in Table 1.

TABLE I. REACH TESTING DATA

No	Trial	Communication Range
1	Trial 1	21 meter
2	Trial 2	23 meter

No	Trial	Communication Range
3	Trial 3	23 meter
4	Trial 4	19 meter
Average reach		21.5 meter

From the results of the experiment in testing four times bluetooth communication, the average value of the range was 21.5 meters. If the Bluetooth range exceeds the range that has been entered in the test, the data communication will not be sent to the maximum or even the communication will be interrupted.

B. Testing of Motor Lifting Power (Thrust)

Lifting (thrust) testing is carried out on each brushless motor used on a quadcopter. Figure 5 is a graph of testing the lift using a 9540 (9 inch) propeller.

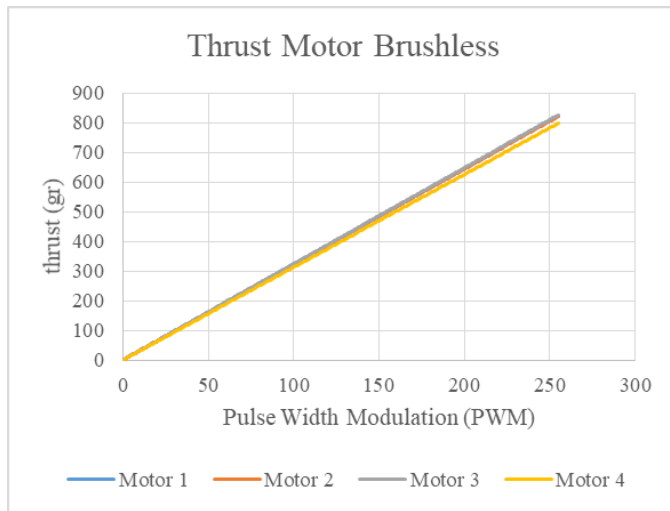


Fig. 5. Motor Lift Power Chart

C. Testing the PID Method

PID method is the main method used for quadcopter stabilization process. In testing this method, to get proportional (K_p), integral (K_i) and derivative (K_d) constants is done by trial and error. When the system is given a constant K_p , K_i , K_d is observed for quadcopter behavior. Testing the PID method is done in the test box. The test box is shown in Fig. 6.

Testing to find a good system response is repeated. By observing the movement of the quadcopter in the stabilization process there will be some differences, including the response of the quadcopter stability to time. Here are some test results using K_p , K_i , K_d that have been done.



Fig. 6. Stability Test

Fig. 7 is a test with a constant value of $K_p = 1.3$, $K_i = 0.04$, $K_d = 5$. The value of this constant is used continuously by the system. In addition to the response to steady state fast enough, the response is not too visible to perform large oscillations. When testing, 200 sensor reading samples were taken with the assumption of data retrieval for four seconds.

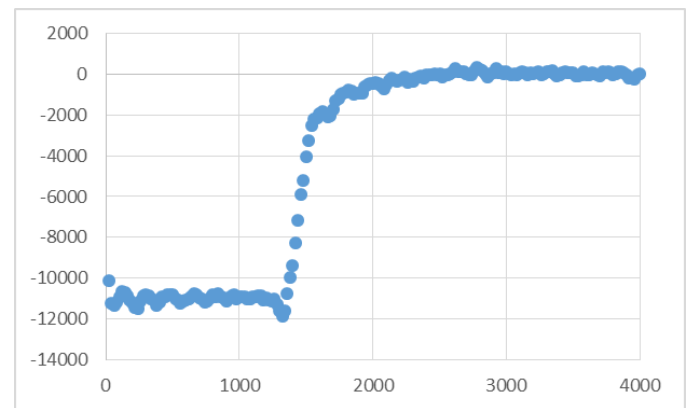


Fig. 7. Results of Testing the PID Method

VI. CONCLUSION AND FURTHER RESEARCH

Based on the testing and analysis results that have been carried out in the research, the following conclusions are obtained:

1. Quadcopter can perform optimal stability movements using the PID method. With a constant value of $K_p = 1.3$, $K_i = 0.04$ and $K_d = 18$.
2. Delivery of altitude data sent via bluetooth communication can work well up to a distance of 21.5 meters.
3. The initial position of the quadcopter during take off will affect the shift of movement during flight.
4. The type of propeller 1045 has a fairly large lift, but the temperature of the motor when used is faster heat.
5. The type of propeller 9450 tends to be more stable in movement.
6. Quadcopter tends to stay away from the initial coordinate point if the flight time is increased.

From the results of the research conducted, for the next development, it is suggested that the following:

1. Pay attention to the specifications of the quadcopter part used, especially in the specifications of the motor for lift strength and propeller type.

2. Communication for quadcopter and ground station should use telemetry. So that the data transmission range can be carried out with a considerable distance and minimize frequency interference from outside.
3. Adding GPS components, to determine the position / location when flying.
4. Provides an electronic shock damper component that is in the quadcopter to minimize the vibration generated by the four brushless rotors.
5. Better mechanical design, to make it easier to implement the control algorithm used.
6. Pay attention to security factors during implementation. Addition of propeller protectors so that the propeller is safe when experiencing a system experiencing errors / crashes.
7. When testing, you must first consider the state of the wind speed, this is to reduce the potential of the quadcopter carried by the wind (flyaway).

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Multi-objective Linear Programming for Supplier Selection and Order Allocation of Raw Material

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Abstract—The production process of a company is very dependent on the availability of raw materials. Raw materials will be available if there are suppliers who send raw materials continuously to the company. As we know that each supplier has difference in price, supply capacity, delivery time and quality of raw materials. Therefore, determining the right supplier is the important process in maintaining company production process. The objective of this study is to select the supplier and allocate orders to the selected supplier by developing the multi-objective linear programming (MOLP). The developed MOLP model will minimize 3 objective functions which include total cost, number of defective raw materials and total delivery time. Numerical examples is provided in this study for application the proposed model. The obtained results prove that the developed model has a better ability to select supplier and allocate the orders to the selected supplier.

Keywords—multi-objective linear programming; supplier selection; order allocation;

I. INTRODUCTION

The supplier is required in the company's production management [1]. The selection of the right supplier is an important activity in the procurement activity [2]. It also can increase the company's competitive advantage [3]. Supplier selection and order allocation are the important process to maintain the availability of raw material. The most important criteria for supplier selection are price, quality and delivery time [4].

Many previous studies have discussed about supplier selection problem. The proposed method for solving the supplier selection problem can be classified into mathematical programming models and multi criteria decision making (MCDM) approach. MCDM approach used to solve supplier selection problem include Analytic Hierarchy Process [5], Analytic Network Process [6], Promethee [7], and Electre [8]. Mathematical programming models used in the proposed models include linear programming, mixed integer programming, and multi criteria optimization [9]. The model that optimized the allocation procurement to suppliers using the single objective mixed integer linier was developed by [10]. Reference [11] developed mixed integer linear programming (MILP) to minimize the total cost of supplier selection with price break. The MILP also was used to solve supplier selection and order quantity allocation by [12]. The

mixed integer nonlinear programming model was constructed by [13] to select and property allocate orders to suppliers.

Reference [14] described the supplier selection problem and how much order quantity should be assigned to each. The two phase fuzzy multi objective Linear Programming (FMOLP) was developed by [15] to solve the supplier selection problem and order allocation under multi price level and multi product. The decision support system was developed by [16] for supplier selection and order allocation in stochastic, multi-stakeholder and multi-criteria environments.

Reference [17] developed integer linear programming (ILP) to determine the selected supplier and allocated the orders to the selected supplier. The developed ILP model had objective function to minimize the total cost. The considered costs in the objective function of this model are purchasing cost, ordering cost and holding cost. There were 8 constraints in the model which include supplier's capacity, order allocation, demand, inventory balance, safety stock, delivery time, binary, non negative and integer. The weakness of model would appear on the delivery time constraint when all alternative suppliers have less delivery time of product than the allowable delivery time of company. So there is no trade off for this constraint when the condition occurs.

This study will improve the weakness of previous model by eliminating the delivery time constraint. In this model will choose supplier which not only have delivery time that meets the company's requirement but also choose supplier which has the fastest delivery time. To achive this purpose, the delivery time constraint in the previous model will be changed to minimized objective functions. This improved model will have more than one objective function. The model which can accomadate the problem with many objective functions is multi-objective linear programming.

As we know, supplier is selected based on criteria of price in general. But sometimes, the price is not guarantee the product quality and delivery time. When the company prioritizes the low price criteria in choosing a supplier, the company actually gets low quality product and slow delivery times. But when the company prioritizes quality of product and fast delivery times, company must pay for products at higher prices. Regarding to conflicts between the three price, quality and delivery time criteria, we propose a multi-objective linear programming approach to solve a supplier

selection and order problem allocation. According to [18], the supplier selection problem is include in MOLP problem.

II. RESEARCH METHODS

The first step begins with developing the MOLP model which includes model assumptions, model components, and model notations. The second stage is the verification of the model. The model verification process is carried out to ensure that the model is logically and mathematically consistent. The third stage is a model test. This stage aims to obtain a model solution by inputting data to the model and solving it with Lingo software.

A. The Model Assumptions

The MOLP model is built on assumptions as follows:

- Demand, supplier's capacity, price, cost and other parameter considered in the model are constant and known.
- Raw material shortage is not allowed from suppliers.
- Only one raw material is considered in model.
- Each supplier has finite capacity.

B. The Model Notations

The component of MOLP model consists of index set, parameters, variable, decision variables, objective functions, and constraint functions. The following notations are used to in the MOLP model.

- Index set

The index set of this model are:

i : Index of supplier, $i = 1, 2, \dots, m$

j : Index of periods, $j = 1, 2, \dots, n$

- Parameters

The following are the parameters used in this MOLP model.

d_j : Demand of raw material at period j

C_{ij} : Capacity of supplier i at period j

p_i : Unit price of supplier i

k : Ordering cost per order of raw material

h_j : Holding cost per unit of raw material at period j

q_i : Defect rate of raw materials from supplier i

SS_j : Safety stock at period j

L_i : Delivery time of supplier i

- Variable

The variable used in this model is as follows:

I_j : Number of inventory at period j (pcs)

- Decision Variables

The developed MOLP model has two decision variables.

X_{ij} : Number of raw material ordered from supplier i at period j

$$Y_{ij} = \begin{cases} 1, & \text{if an order is placed on supplier } i \text{ at period } j \\ 0, & \text{otherwise} \end{cases}$$

C. Objective Functions

The developed MOLP model has three objective functions consisting of minimize total costs (Z_1), minimize number of defective raw materials (Z_2), and minimize total delivery time (Z_3).

- Minimize the total cost (Z_1)

The total cost is sum of the purchasing cost, the ordering cost and the holding cost. The purchasing cost is obtained from raw material price multiplied by number of raw material ordered to the selected supplier. The ordering cost is calculated from total ordering cost of all selected suppliers. The holding cost is obtained from the holding cost per unit raw material multiplied by number of inventory.

$$\text{Min } Z_1 = \sum_{i=1}^m \sum_{j=1}^n p_i X_{ij} + k \sum_{i=1}^m \sum_{j=1}^n Y_{ij} + \sum_{j=1}^n h_j I_j \quad (1)$$

- Minimize number of defective raw materials

The quality is one important of quality is one of the important criteria in supplier selection problems and is widely used in practical situations [19]. Raw materials quality in this model is represented by the number of defective products. The number of defective raw materials is obtained from sum of multiplication between defect rate of raw material from selected suppliers and the number of product ordered.

$$\text{Min } Z_2 = \sum_{i=1}^m \sum_{j=1}^n q_i X_{ij} \quad (2)$$

- Minimize total delivery time

The total delivery time is obtained from total delivery time of selected suppliers.

$$\text{Min } Z_3 = \sum_{i=1}^m \sum_{j=1}^n L_i Y_{ij} \quad (3)$$

Multiple objective functions in the MOLP model will be changed to a single objective function by adding weight to each objective function. Total weight equals one. Assuming that W_1 is the weight for the total cost minimization, W_2 is the weight for the number of defective raw materials minimization, and W_3 is the weight for the total delivery time minimization. The following single objective function is formed.

$$\begin{aligned} \text{Min } Z = & W_1 \left[\sum_{i=1}^m \sum_{j=1}^n p_i X_{ij} + k \sum_{i=1}^m \sum_{j=1}^n Y_{ij} + \sum_{j=1}^n h_j I_j \right] \\ & + W_2 \left[\sum_{i=1}^m \sum_{j=1}^n q_i X_{ij} \right] + W_3 \left[\sum_{i=1}^m \sum_{j=1}^n L_i Y_{ij} \right] \quad (4) \end{aligned}$$

D. The Constraint Functions

The constraints of MOLP model consists of supplier capacity, demand, order allocation, inventory balance, safety stock, nonnegative and binary.

- The capacity of supplier

$$X_{ij} \leq C_{ij} \quad \forall i, j \quad (5)$$

Supplier's capacity is extensively used in the literature of supplier selection problem. The number of raw material ordered to suppliers must consider the supply capacity of each supplier. The constraint in (5) ensures that the number of raw material ordered to suppliers must not exceed the supply capacity of suppliers.

- Demand

$$\sum_{i=1}^m X_{ij} + I_j \geq d_j, \quad \forall j \quad (6)$$

The number of raw material ordered from supplier is also affected by the raw material inventory and demand. The constraint in (6) shows that the number of raw material ordered plus the inventory of raw materials must exceed the demand. This constraint ensures that demand at the each period must be met.

- Order allocation

$$X_{ij} \leq M C_{ij} Y_{ij} \quad \forall i, j \quad (7)$$

Order allocation is the determination of the number of raw material ordered to the supplier. Ordering the raw material to suppliers is done on selected supplier. The number of ordered raw material is less than the order allocation. M is the biggest positive number.

- Inventory balance

$$I_j = I_{j-1} + \sum_{i=1}^m X_{ij} - d_j, \quad \forall j \quad (8)$$

Inventory balance of raw material needs to be maintained to smooth the production process. The number of current inventory is affected by the number of inventory in the previous period, the number of ordered raw material, and demand.

- Safety stock

$$I_j \geq SS_j, \quad \forall j \quad (9)$$

The inventory quantity for the current period must be greater than the safety stock. Safety stock is used to prevent the shortages, defect and raw material damage during production process.

- Binary

$$Y_{ij} \in (0,1), \quad \forall i, j \quad (10)$$

The binary constraint shows that order allocation will be placed on to a supplier with a value of 1 and no order allocation to a supplier with a value of 0.

- Nonnegative and integer

$$X_{ij}, I_j \geq 0 \text{ and integer} \quad \forall i, j \quad (11)$$

The result obtained must be positive and integer.

The complete MOLP model is as follows:

$$\begin{aligned} \text{Min } Z = & W_1 \left[\sum_{i=1}^m \sum_{j=1}^n p_i X_{ij} + k \sum_{i=1}^m \sum_{j=1}^n Y_{ij} + \sum_{j=1}^n h_j I_j \right] \\ & + W_2 \left[\sum_{i=1}^m \sum_{j=1}^n q_i X_{ij} \right] + W_3 \left[\sum_{i=1}^m \sum_{j=1}^n L_i Y_{ij} \right] \end{aligned}$$

Subject to:

$$\begin{aligned} X_{ij} &\leq C_{ij} && \forall i, j \\ \sum_{j=1}^n X_{ij} + I_j &\geq d_j, && \forall j \\ X_{ij} &\leq M C_{ij} Y_{ij} && \forall i, j \\ I_j &= I_{j-1} + \sum_{i=1}^m X_{ij} - d_j && \forall j \\ I_j &\geq SS_j, && \forall j \\ Y_{ij} &\in (0,1), && \forall i, j \\ X_{ij}, I_j &\geq 0 \text{ and integer}, && \forall i, j \end{aligned}$$

III. RESULT AND DISCUSSION

This section will provide numerical examples for the application of this proposed model. There are eight raw material suppliers that will be chosen to fulfill the orders during four periods. Each supplier has difference in price, supply capacity, delivery time and defect rate of raw materials. Table 1 shows the demand of raw material for four periods. Table 2 summarize the supplier's parameters.

The results obtained in this model will be compared to the previous model. For comparison purposes, the same data in [13] is used. In addition, the value of $W_1=0.5$, $W_2=0.3$, $W_3=0.2$, and the defect rate of each supplier. The ordering cost is Rp. 5,000 /order. The holding cost is Rp.100/pcs/period. The initial raw material inventory is 3,200 Pcs and safety stock is set at 5% of demand per period.

TABLE I THE DEMAND OF RAW MATERIAL

Period	Demand (pcs)
1	37,224
2	32,668
3	59,032
4	39,764

TABLE II THE SUPPLIER'S PARAMETERS

Suppliers	Capacity (pcs)	Price (pcs)	Delivery Time (days)	Defect Rate (%)
1	22,050	6,800	2	1
2	18,624	6,700	3	1
3	10,500	5,900	2	4
4	6,900	6,650	4	3
5	9,000	5,950	1	4
6	2,225	5,300	1	5
7	8,000	6,600	4	3
8	1,298	6,700	2	1

Supplier parameters and other data are included in the MOLP model and solved by Lingo. The Lingo solver produce global optimum output with value of the objective function, $Z = 523,503,000$. Table III shows the result of selected suppliers and order allocation of the proposed model. While table IV is a summary of results from the previous model.

TABLE III THE SELECTED SUPPLIERS AND ORDER ALLOCATION OF MOLP MODEL

Suppliers	Order Allocation (pcs)			
	Period 1	Period 2	Period 3	Period 4
1	0	0	3,804	0
2	0	0	18,624	2,175
3	10,500	10,500	10,500	10,500
4	6,160	2,715	6,900	6,900
5	9,000	9,000	9,000	9,000
6	2,225	2,225	0	2,225
7	8,000	8,000	8,000	8,000
8	0	0	1,298	0
Safety stock	1,861	1,633	2,952	1,988

Based on the results in table 3 for the current model, it is found that there are five suppliers are selected to fulfill the company's order in the first period. They are supplier 3,4,5,6,7. Order allocation to the selected supplier are supplier 3 = 10,500 pcs, supplier 4 = 6,160 pcs, supplier 5 = 9,000 pcs, supplier 6 = 2,225 pcs, and supplier 7 = 8,000 pcs. The total order allocation in the first period is 35,885 pcs. The safety

stock in the first period is 1,861 pcs. The selected supplier to fulfill the orders in the second period are the same with the selected supplier in the first one. But the allocation of orders to supplier 2 is different. Order allocation of raw material to the supplier 2 in the second period is 2,715 Pcs. The total order for raw materials in second period is 32,440 pcs. The inventory in period 2, $I_2 = 1,633$ pcs.

There are seven selected suppliers in the third period for the current model. Only supplier 6 is not the selected supplier. Order allocation to each supplier are supplier 1 = 3,804 pcs, supplier 2 = 18,624 pcs, supplier 3 = 10,500 pcs, supplier 4 = 6,900 pcs, supplier 5 = 9,000 pcs, supplier 7 = 8,000 pcs, and supplier 8 is 1,298 pcs. The total order of raw material to all selected suppliers is 58,126 pcs. The final inventory in period 3 is 2,952 pcs.

In the fourth period for the current model, there are 6 selected suppliers to supply the raw materials. They are supplier 2, 3, 4, 5, 6, and 7. The order allocation to each supplier are supplier 2 = 2,175 pcs, supplier 3 = 10,500 pcs, supplier 4 = 6,900 pcs, supplier 5 = 9,000 pcs, supplier 6 = 2,225 pcs and supplier 7 = 8,000 pcs. The total order of raw materials in the fourth period is 38,800 pcs with an initial inventory of 2,952 pcs and the final inventory in period 4 is 1,988 pcs.

The conclusion that can be drawn from table III is that there are 4 suppliers that are always selected to meet the demand. They are supplier 3, 4, 5 and 7. It can be said that suppliers 3, 4, 5, and 7 are the main suppliers. While the suppliers 1, 2, 6, and 8 are not always selected. The result also shows that the supplier 3, 5, and 7 are the main suppliers with the order allocation according to their maximum capacity.

TABLE IV THE SELECTED SUPPLIERS AND ORDER ALLOCATION OF PREVIOUS MODEL [17]

Suppliers	Order Allocation (pcs)			
	Period 1	Period 2	Period 3	Period 4
1	0	0	0	0
2	0	0	18,624	2,175
3	10,500	10,500	10,500	10,500
4	6,160	6,519	6,900	6,900
5	9,000	9,000	9,000	9,000
6	2,225	2,225	2,225	2,225
7	8,000	8,000	8,000	8,000
8	0	0	1,298	0
Safety stock	1,861	5,437	2,952	1,988

Comparison of the results obtained from both models can be concluded that: (1) both models produce the same number and composition of suppliers for each period, (2) both models have the same allocation of orders to each supplier in the first and fourth periods, (3) there are differences in order allocations for periods two and three for both models, (4) the previous model

produces 5 main suppliers while the current model produces 4 main suppliers. Related to the results of the comparison of the two models point 3, in period 3, the current model selects supplier 1 to supply raw materials to the company compared to the previous model that chose supplier 6. This is the optimal compromise solution of the model. Supplier 1 has a higher price but low defect rate and moderate delivery time compared to supplier 6. While supplier 6 has a lower price and delivery time but the defect rate is higher.

IV. CONCLUSION

Supplier selection and order allocation are the important process to maintain the availability of raw material. The objective of this study is to select the suppliers and allocate the order to the selected suppliers. The developed MOLP model proved able to be used to select the best supplier and allocate orders to the selected supplier. The model consider more comprehensive criteria of supplier selecting problem and also overcome the conflicts between criteria. So that the solution obtained is more optimal. For further research, the model can be integrated with pairwise comparison methods to determine the weight of the objective function. Model development can also be implemented by considering other relevant criteria.

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A New framework of e-Participation using data science to support community empowerment

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Abstract—e-Participation is an interesting field capturing how technology can support community empowerment in public decision making. Data Science is also an emerging field that uses methods, processes, algorithms and systems to develop pattern, knowledge and insights from structured and unstructured data. It is still limited research capturing and integrating e-participation and data science into one framework. This paper aims to develop a new framework that integrate e-participation and data science frameworks. Hopefully, this research contributes a new framework of e-Participation using data science approach. The novel framework is collaborating technological and non-technological aspects, multidisciplinary approaches and accommodating the emerging technologies nowadays. This research has implications for theory by adding the new framework into e-Participation, e-Government, Information Systems, Data Science fields. Another important practical implication is that practitioners and decision makers in government could consider elements in the framework to get successful in the technology implementation for supporting citizen participation

Keywords—A New framework; e-Participation; Data Science

I. INTRODUCTION

e-Participation is an interesting field capturing how community could be empowered in public decision making using technology. Participation is also needed in various areas, such as politics, public administration, business, and others. In politics and public administration, community can use e-voting to participate in decision making about public policy. Moreover, in business field, staffs of a company might have opportunity to give suggestion for improving the quality of the product. Data Science is also an emerging field that contain data mining and statistics to manipulate data and find out useful pattern to use the data. It is still limited research capturing and integrating e-participation and data science into one research. This paper aims to develop a new framework that integrate e-participation and data science frameworks. Hopefully, this research contributes a new framework of e-Participation using data science approach. This research has implications for theory by adding the new framework into e-Participation, e-Government, Information Systems, Data Science fields. For practice, practitioners and decision makers can use this framework to improve quality of e-Participation implementation using data science approach.

The brief structure of this paper consist of Introduction, Literature Reviews, Research Methods, Analysis and Discussions, as well as Conclusions sections.

II. LITERATURE REVIEWS

A. E-Participation

E-Participation is an emerging field that has various definitions, such as [1] explain e-participation refers to information and communication technologies (ICT) to support conversion of citizen participation in decision making process; According to [2] that defined e-participation as supporting citizen empowerment and open participation using ICT to improve information accessibility and public services and support citizen involvement in public policymaking. Additionally, [3] also defined e-participation as “*the various dynamic activities of interaction, communication, participation and management through several electronic technologies, implemented by numerous stakeholders, such as internal, external, dominant and less dominant stakeholders, which are supported by support systems, influencing and influenced by many complex factors, changes, laws and policies as well as financial capital*”. Furthermore, there are existing E-Participation frameworks, such as [4] that developed three levels of participation for supporting e-democracy initiatives and policy making; [5] proposed a framework for evaluating e-Participation projects and tools; [6] capture a framework consist of various layers: the democratic processes, participation scope, participation techniques, tools classification and ICT technologies; [1] captured a model consists of elements of e-Participation actors, activities, effects, evaluation, contextual factors and the research approach; [7] also proposed a domain model of e-participation consists of the stakeholder, participation process and ICT Tool domains; [8] developed a framework of ICT application for E-Participation implementation; [9] captured a framework contains 7 stages: policy and capacity building, planning and goal settings, programs and contents development, process and tools, promotion, participation, postimplementation analysis; [10] proposed guidelines with six-step to help development and implementation of e-Participation projects; [11] examined an evaluation framework for e-participation in parliaments; [10] developed a framework for e-Participation projects contains a holistic engineering approach and supports communications between project actors with various levels of technical and political backgrounds from different perspectives; [12] proposed Actor-Network Theory (ANT) approach to develop e-Participation Framework in Malaysia; [13] emphasized a framework for evaluating the impact of eparticipation implementations; [14] developed a model for the e-participation framework; [15] also offered a model of e-participation based

on school case studies in the UK and Indonesia; [3] proposed a generic model of e-participation; [16] developed a conceptual model that combine Internet of Things (IoT) and e-Participation.

B. Data Science

In this literature reviews, we would like to focus on data science frameworks as follows: [17] captured data science, data source, data scale, data story, and data scientists; [18] explained about data science expertise, venn diagrams, goals and deliverables, process, skills and education, data analysts and data engineers, also the data scientist's toolbox; [19] described data science definition, comparing data science with data analysis, process of data science, tools, skills, scope, advantages, how data science is different from big data; [20] explained data insight, data product, the skill set requirement, analytics and machine learning; [21] emphasized the life cycle of data science and data scientist profile; [22] presented structured and unstructured data, business intelligence and data science, life cycle, model planning and building tools; [23] reviewed about statistics and associated data science methods in bioimage informatics; [24] emphasized software for supporting big data science for data scientists and big data analytics frameworks based on clouds; [25] reviewed application of data science to materials microscopy, such as denoising, drift and distortion correction, spectral unmixing, and the use of simulated experiments to develop information about materials from microscopy data; [26] studied neural data science methods for analyzing neural time-series data with single-neuronal precision; Also, [27] explored emerging trends of big data technologies.

III. RESEARCH METHODS

This research is conducted based on desk research. The first stage is designing research methods. After that, we did literature reviews about existing frameworks of e-participation and data science existing. Then, we developed a new framework of e-participation framework by adding data science elements. Furthermore, we analysed the new framework to identify advantages and disadvantages as well as other interesting things. Last stage, this research will emphasize conclusions, contributions and further research.

TABLE I. STEP BY STEP RESEARCH METHODS

Step	Activity	Output
1	Designing research methods	Step by step research methods
2	Literature reviews about e-Participation and Data Science frameworks	List of the existing e-participation and data science frameworks
3	Develop a new framework of e-Participation using Data Science approach	A new framework of e-Participation using Data Science Approach
4	Analyse the advantages, limitations and other interesting things of the framework	Analysis about the advantages, limitations and other interesting things of the framework
5	Emphasize the conclusion, conclusion and identify the further research regarding collaboration between e-Participation and Data Science	Conclusion, contribution and further research

The existing frameworks of e-Participation were collected from various references, such as conference proceedings, journals, books and PhD dissertation of the first author. We searched the references from the Google Scholar engine by typing the keywords e-Participation, data science, framework, model. Furthermore, the relevant references were accessed and analysed.

IV. A PROPOSED FRAMEWORK

The proposed framework is presented in the Fig. 1 below. It is a continuation work based on previous frameworks. The developed framework consist of a main part such as Stakeholders, Media, Object/Planning action, support system and data science approach. The stakeholders are wider stakeholders, NGO, citizen, government, politicians, researchers and others. The media consist of existing electronic technologies and Internet of Things (IoT). The existing electronic technologies are website, mobile, social media, radio, TV and others.

The IoT consist of perception, network and service (application) layers. The object/planning action include government and non-government action(s)/activity(s). The support systems are organization structure, procedures, trainings and others. The stakeholders have two ways interaction, communication, participation and management using media and the media have two ways interaction, communication, participation and management of object/planning action (s).

Furthermore, the stakeholders provide and receive support systems. It gives support to the two ways interaction, communication, participation and management. The main part of the model is influencing and influenced by financial capital, laws and policies, changes and complex factors. The complex factors consist of common, such as social, cultural, economy, politics and specific factors, such as weather and psychology of specific place and people. Those elements above are based on the previous research. Then, the elements of data science is added as an approach.

The data science approach consist of data sources, approach, tools and stages. Data structures consist of both structured and unstructured data in logs, cloud data, SQL, NoSQL, and text. Furthermore, the approaches are statistics, machine learning, graph analysis, neuro-linguistic programming (NLP). Moreover, the tools include RapidMiner, BigML, Weka, R, Python, SQL, Spark, Scala, Julia, Java, MySQL, Hadoop, Tableau and SAS. The stages consist of capture, maintain, process, analyze and communicate. The capture stage includes data acquisition, data entry, signal reception and data extraction. The maintain stage contains data warehousing, data cleansing, data staging, data processing and data architecture. Moreover, the processes are data mining, clustering/classification, data modeling and data

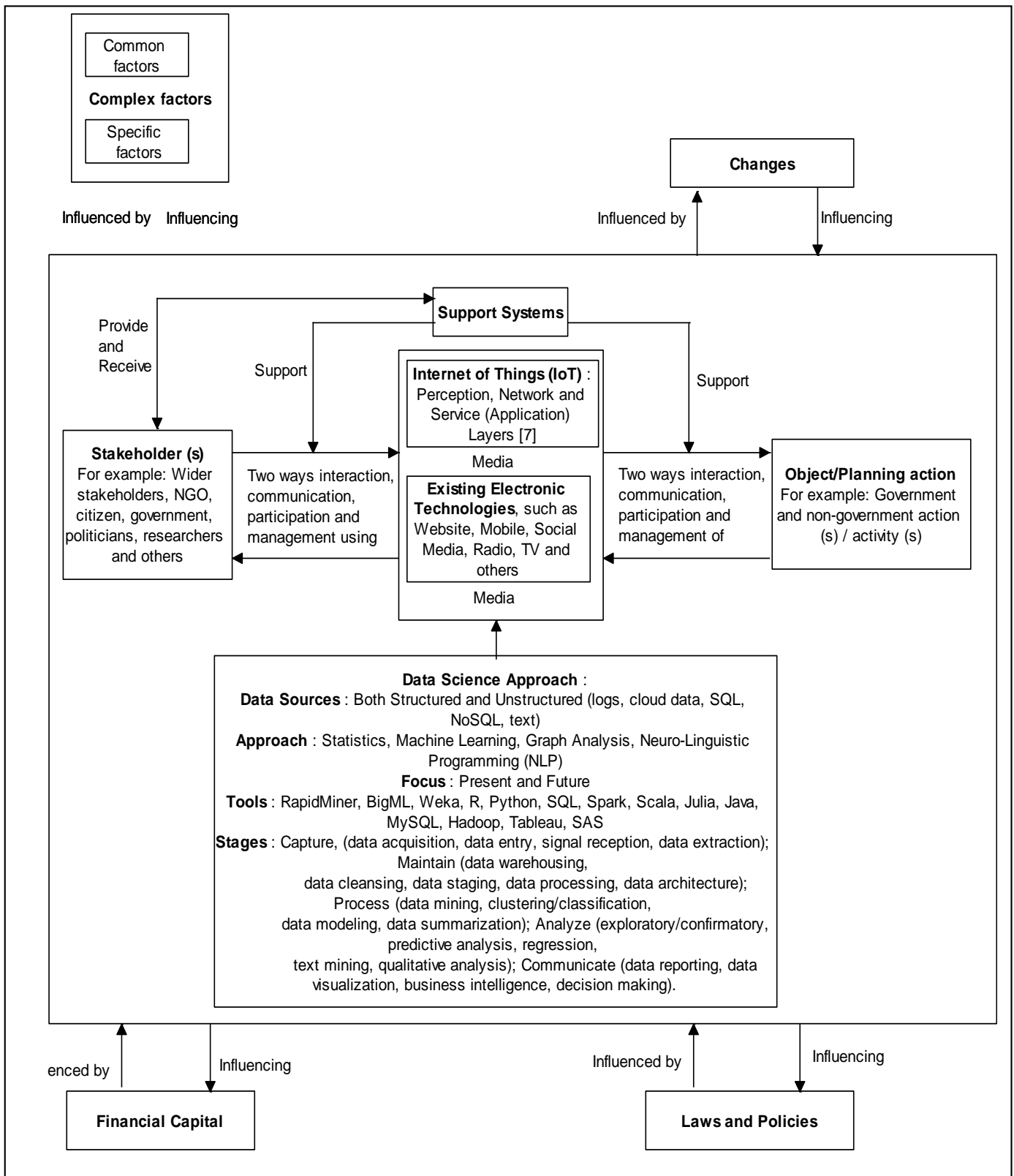


Fig. 1 A New Framework of e-Participation using Data Science Approach

summarization. Furthermore, the analyze stages consist of exploratory/confirmatory, predictive analysis, regression, text mining and qualitative analysis. Then, the communicate stages include data reporting, data visualization, business intelligence and decision making. [17][18][19][20][21][22][23][24][25][26][27].

The framework in the figure 1 above has novelty by adding data science approach in the existing model of e-participation developed by [3] and [16]. Furthermore, the proposed framework above has some advantages as follows:

1. Collaborating multidisciplinary approach, such as finance, law, informatics, information system, management, public administration and specifically e-participation and data science fields.
3. Combining technological, such as website, mobile, Internet of Things (IoT) and non-technological aspects, such as finance, laws and policies.
4. Accommodating various and trending technologies and approach, such as and Data Science Approach.

Moreover, the developed framework also has limitations, such as it is still conceptual and has not been implemented in empirical research.

Data Science Approach has potential benefit to support digital community empowerment, especially in social media. Twitter, Facebook and other social media platforms have a lot of data that relevant with community encouragement. Therefore, data analytics of twitter and facebook could be very useful for practitioners and decision makers in government.

V. CONCLUSIONS. CONTRIBUTIONS AND FURTHER RESEARCH

The aim of the present research was to examine and develop a new framework of e-participation using data science approach. This study has shown that data science approach can be added in a novel framework of e-participation. The principal theoretical implication of this study is that this new framework can be develop body of knowledge for e-participation, data science, internet of things (IoT), informatics, information systems, law, management, public administration, finance fields. Another important practical implication is that practitioners and decision makers in government could consider elements in the framework to get successful in the technology implementation for supporting citizen participation. This work contributes to existing knowledge of e-Participation by providing a new framework of e-Participation using data science approach. A further study could explore the framework of e-Participation and deep learning.

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Cow Weight Estimation Using Local Adaptive Thresholding Method And Connected Component Labelling

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Abstract— The development of technology, information and communication provides a new alternative to predict cow weight through Image Processing. This study utilizes Image Processing in visualizing the measurement of Chest Circumference and cow body length automatically. The cow weight estimation are very dependent on cow image segmentation result. Image segmentation method used in this study is local adaptive thresholding combined with the Connected Component Labeling (CCL) method. The implementation of the Chest Circumference and Body Length endpoints in the foreground is converted into centimeters (cm) to ensure cow weight estimation can be calculated using the Lambourne formula. In this study, the accuracy of RMSE was obtained from the cow weight data taken at 150, 170 and 190 cm distance. The accuracy is 20.35, 30.77 and 23.33 respectively. This research can be contribution to development of local cattle farms in Indonesia.

Keywords—cow weight; calibration; edge detection; connected component labeling

I. INTRODUCTION

Data on cow weight is very important information for farmers and buyers. On the farmer's side, this information can avoid losses when a cow is sold. The weight is used to estimate price [1]. On the other hand, the buyer could determine the accuracy of cow weight to be purchased.

Nevertheless, there are farmers who roughly estimate cow weight, therefore the results are not accurate enough. Current technological, information, and communication developments have provided alternative solutions to determine cow weight. It could be conducted through Image Processing[2-4]. One image processing widely used in image reconstruction is the image segmentation method [5]. In the computer vision field, image segmentation plays a crucial role as a preliminary step for high-level image processing. [14].

Previous research conducted on image processing is carried out, designed and applied applications with the use of digital

image processing techniques. It is capable to predict and classify cow weight using a combination method of K-Means Clustering with Active Contour Model. Feature extraction obtained is chest circumference and body length. It uses SVM Multiclass to classify. Based on this study, the best accuracy results obtained from the system is 0.5 ratio at 87.53% to determine cow weight with 8.26 seconds computation. The amount of data used was 100 training data and 17 test data [6].

Other research used K-Nearest Neighbor (K-NN) to estimate cow weight. The first step involved is preprocessing. It consists of resizing and contrast stretching operations. Research result exhibited the accuracy value of cow weight estimation at 28.19% with 21.44 seconds computing time [7].

A system with the use of digital image processing techniques that can facilitate cow weight estimation has designed and implemented using the Gabor Wavelet method and Support Vector Machine Multiclass classification [8]. The best accuracy value obtained was 77.78% at computing time of 20.25608 seconds. The amount of data used was 10 training data and 8 test data [8].

The application on estimating cow weight by utilizing cameras on Android-based smartphones has been analysis [9]. It applies the DAHAGA formula which has an accuracy of 97.9% and uses a template matching method that compares the original object with the image captured by the camera. The application executes the DAHAGA formula and displays the weights as the final result [9].

Several studies mentioned above used the determination of manual endpoint measuring parameters. Therefore it still involves the user to determine the point of chest circumference and length of a cow. This research advances theory on finding endpoints automatically.

Thus, this research provides a unique theoretical contribution to determinate endpoints automatically depends on the results of image segmentation. Image segmentation in this study uses local adaptive thresholding method which is combined with the CCL method to mark objects detected as cows.

The remainder of this paper is organized as follows: an analysis segmentation using local adaptive thresholding and connected labelling is presented in Section 2. In Section 3 implementation of segmentation and prediction of the cow weight. Finally, some conclusions are shed.

II. RESEARCH METHOD

A. Segmenting

Segmentation is the process of separating objects with backgrounds. By using the segmentation process, each object in the image can be taken individually. It is used as input for other processes [10]. In computer science, especially in computer vision and image processing, segmentation are the most developed methods. There are 3 stages in the own segmentation process, namely grayscale, image binarization and coloring. Grayscale is the stage to divide the intensity that will be used as white and the intensity that will be used as black to simplify the image that calculates RGB values. The second is the binarization process. The image binarization process is applied by giving black and white color to the image. White represents background or background and black represents objects or vice versa. The third is coloring, coloring is done to make the noise contained in the image white to ensure the results of the segmented object are well segmented. Therefore ensuring pixel calculation more accurate [10].

B. Local Adaptive Thresholding

Thresholding produce a binary image. It has two gray level values: black and white. The following is a grayscale image thresholding process to produce a binary image:

$$G(x, y) = \begin{cases} 1, & \text{if } f(x, y) \geq T \\ 0, & \text{if } f(x, y) < T \end{cases} \quad (1)$$

Description:

$g(x,y)$: grayscale binary image $f(x,y)$

T : threshold value

T value has a very important role in thresholding process. The quality of the binary image depends on the T value used.

The method used in this study is the local adaptive thresholding method. In this method, local threshold values can be calculated in one of three ways:

$$T = \frac{\sum_{(x,y)} \sum_{e \in W} f(x, y)}{N_w} - C, \text{ or} \quad (2)$$

$$T = \text{median}\{f(x, y), (x, y) \in W\} \quad (3)$$

$$T = \frac{\max\{f(x, y), (x, y) \in W\} + \min\{f(x, y), (x, y) \in W\}}{2} \quad (4)$$

Information:

W : the processed block

N_w : the number of pixels in each W block

C denotes a constant that can be determined independently if $C = 0$ means the threshold is equal to the average value of each pixel in the block.

Using three methods above, it successively calculate the T value by calculating the mean, median, and average maximum and minimum values of pixels in the window [11].

C. Connected Component Labeling

Connected Component Labeling is a method used to classify regions or objects in a digital image. The CCL algorithm applies pixel connectivity theory on the image. All pixels in a region are connected or are also referred to as correlated when adhering to pixel adjacency and proximity. Pixel proximity rules utilize the proximity between one pixel and the other pixel. Therefore, every pixel correlated possess closeness to each other because it has a neighboring relationship. The image that can be processed using the CCL algorithm is in the form of binary images or monochrome images. For neighboring pixel itself, it must have a length or distance of 1 unit or directly between the pixel or the other without any intermediary [12].

There are 2 rules in the CCL method, namely 4-connectivity and 8-connectivity, which is described below:

a) 4-Connectivity

- 1) Searching for each pixel in an image, starting from the row to the matrix column to finding different pixel points (p)
- 2) After finding different pixels, it will check pixel p neighboring unit/pixel to the left and above it.
- 3) If the neighboring pixel value is $p=0$, then it is marked (table) new.
- 4) If the two neighboring pixel value $p = 1$ then one of the pixels is marked as p , then make a note that the two different pixels are equivalent.

At the end of the process, all pixels possessing value of 1 (in binary imagery) have been labeled. Nevertheless, there may still be many equivalent values. Therefore the equivalent values are sorted simultaneously in equivalent classes and given a different sign in each equivalent class.

b) 8-Connectivity

The steps in 8-connectivity possess the same principle as 4-connectivity. A slight difference is apparent when searching for each line 4-connectivity. After the pixel value (p) was found, then it is connected with the upper and left pixel. However, on 8-connectivity it will connect each pixel by checking the top, left, diagonal upper left and diagonally upper right. Following are the steps of 8-connectivity:

- 1) If all four neighboring pixels value are 0 then p is given a new marking.
- 2) If only one of the neighboring pixels is 1 then it is marked by the neighboring pixel as p
- 3) If two or more neighboring pixels value is equivalent to 1 then mark one of them as p . All the neighboring pixel possessing value 1 are considered equivalent.

The last process of 4-connectivity or 8-connectivity is to check or scan the image then replace each sign with the mark of the equivalent class.

D. Lambourne

Lambourne is a formula used in calculating the weight of an animal, such as a cow and goat, based on chest circumference and body length [13].

$$BB = \frac{LD^2 \times PB}{10840} \quad (5)$$

Information:

BB = Weight (kg)

LD = Body Length (cm)

BB = Chest Circumference (cm)

E. System Design

The system design in this study includes several stages, namely data input, segmentation, determination of endpoints, conversion of pixels to cm, and calculation of the cow weight estimation.

This study used to input data in the form of images of cow obtained from one slaughterhouse (RPH) by taking photos directly using a cell phone, with an angle of 90°. Data taken was 117 images with three different distances: 150cm, 170cm and 190cm. Image taken on each distance was 39.

Segmentation stage was conducted using two methods, the local adaptive thresholding method. The segmentation result were processed using the second method (CCL) to classify the region.

The region of the cow object formed from the segmentation process is used to determine the end point of the chest circumference (LD) and body length (PB) automatically [9].

After determining the endpoint, the pixel was converted into cm because as the endpoint results are still in the form of pixels. The conversion results will be used to calculate cow weight. Calibration is a method used to convert pixels to cm is calibrated. Calibration values are obtained from the average ratio of the original size (cm) to the size of the image (pixel). After the calibration value is obtained, the conversion of pixels to cm is done by means of the chest circumference multiplied by the calibration results as well as the length of the body.

The final stage is to calculate cow weight using the Lambourne formula based on the value that has been converted to cm. Flowchart of the methods is shown in the Fig.1 below

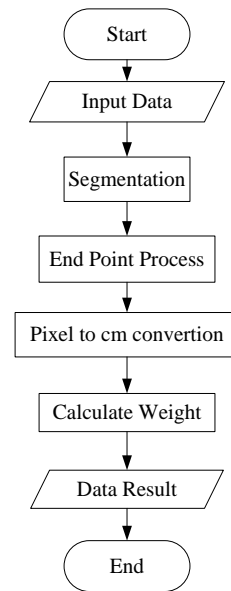


Fig. 1. Flowchart of Cow Weight Estimation System

III. FINDING AND RESULT

A. Segmentation Experiment

The Adaptive function is used for segmentation using the local adaptive thresholding method. It determined the threshold value (T) using the mean. If it is greater than T, the pixel value is 1. Otherwise, the value is 0. The centroid is used to determine the midpoint of the cow object. X and Y points were constructed in order to check the centroid. Y coordinates were assessed to find the background. After it was determined, the coordinate point stops and forms chest circumference and body length

B. Estimation result

The assessment was carried out in accordance with the system design, which had been made before using a cow object captured from 3 different distances. This assessment was conducted to determine the cow weight estimation from the 3 distances.



Fig. 2. Cow Image

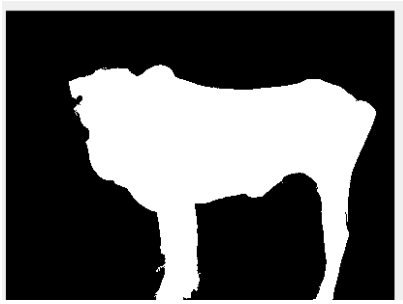


Fig. 3. Segmentation dan CCL Image Result

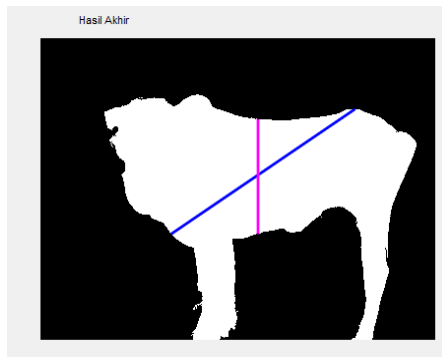


Fig. 4. Determination of the Chest Circumference (LD) and Cow Body Length (PB) endpoints.

TABLE I. COW WEIGHT ESTIMATION

Data no.	Table Column Head			
	Manual Measurement	Scenario 1	Scenario 2	Scenario 3
1	400	221	203	224
2	203	275	187	206
3	235	5	0	113
4	203	218	0	0
5	173	259	206	227
6	354	220	0	0
7	270	291	309	341
8	226	232	210	210
9	202	205	8	0
10	280	240	181	215
11	291	417	0	268
12	234	427	372	315
13	159	275	195	214
14	195	162	207	214
15	262	166	220	242
16	413	246	0	123
17	197	293	242	234
18	354	211	232	258
19	438	304	368	311
20	226	368	229	227

Data no.	Table Column Head			
	Manual Measurement	Scenario 1	Scenario 2	Scenario 3
21	159	273	218	239
22	252	266	0	5
23	145	172	0	0
24	390	275	0	7
25	179	149	157	141
26	210	205	200	216
27	173	317	223	224
28	377	260	235	238
29	320	279	0	209
30	252	303	0	258
31	342	422	307	332
32	253	160	0	132
33	440	277	26	285
34	443	260	230	243
35	193	223	0	0
36	210	246	0	123
37	195	211	232	258
38	173	368	229	227
39	179	576	0	0

Based on Table 1, the results of the cow weight estimation assessment result through measurement of Chest Circumference (PB) and Body Length (PB) resulted in varying estimated values. Scenario 1 was cow image taken at a distance of 150 cm. Whereas scenario 2 was taken at 170 cm and scenario 3 at 190 cm.

The evaluation process of cow weight estimation system is done by measuring the accuracy of the model forecast results using the Root Mean Square Error (RMSE). RMSE is the average value of the sum of squared errors, it can also state the size of the error generated by a forecast model.

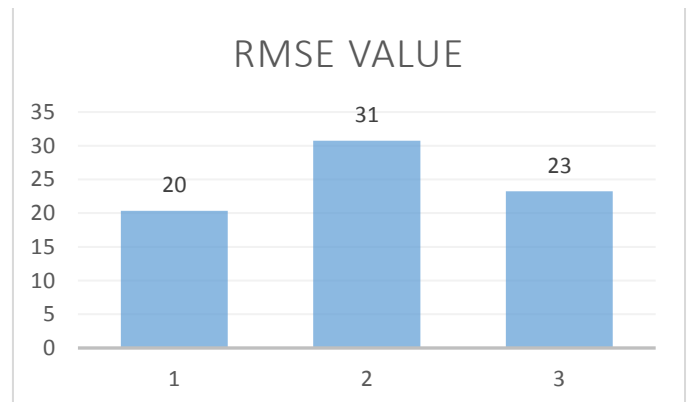


Fig. 5. Cow weight estimation system accuracy graph

Fig. 5 exhibits that scenario 1 has the smallest RMSE value. Low RMSE values indicate that the variation of the values generated by a forecast model is close to the variation of the observation value. Whereas scenario 2 has the highest RMSE value.

IV. CONCLUSION AND FURTHER RESEARCH

Assessment evaluation phase in scenarios 1, 2 and 3 exhibited that distance does not significantly affect the estimation results. The main factor in cow weight estimation is the captured image possess complex background. Therefore the segmentation process is bad. The cow object produced by segmentation is very influential in determining the endpoint of the Cow Circumference and Body Length as the main parameters of the cow weight estimation.

The results of research on the development of cow weight estimation software can contribute directly for local farmers to selling of cows easily.

Furthermore, some of the techniques reviewed in this paper can be used as a previous step for another technique. For example, an optimization thresholding method could be the input for an image segmentation. Therefore, it would be our further research.

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Designing Magnetic Stirrer Hot Plate Using Contactless Infrared MLX90614 Temperature Sensor Based On PID Controller

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Abstract—Magnetic stirrer hotplate is a laboratory equipment which is used to heat and homogenize any chemical solvent. This equipment is usually used in chemical, microbiology and pharmacy laboratory. It is equipped with stirrer which is made up from magnetic stir bar. Our proposed magnetic stirrer hot plate controller uses ATmega16 microcontroller and equipped with temperature sensor MLX90614 to measure and monitor chemical solvent temperature and using DC (Direct Current) motor as a mover of stirrer. This tool is designed to have two type menus: automatic and manual. If using the automatic menu, the user only selects the mixing of the solution in the automatic menu. On the other hand when manual menu is selected temperature (30-60° celcius), stirring velocity (400-1600 rpm) and stirring time (1-30 minute) which can be seen at LCD display. The simulation result of PID (Proportional Integral Derivative) controller indicates stable condition when when $K_p = 0,011$, $K_i = 0.000001$, and $K_d = 0.000012$.

Keywords—hot plate, magnetic stirrer, infrared MLX90614, PID controller.

I. INTRODUCTION

The electronic technology development has take a role at industrial and medical technology. One of the positive impact in medical technology is the improvement of magnetic stirrer hot plate. It is used to heat chemical solvent or tissue which is usually used in microbiology, chemical and pharmacy laboratory. It is equipped with stirrer, made from magnetic stir bar, that homogenize and stabilize chemical solvent and keep the tissue temperature. It is equipped with temperature and stir velocity setting. To measure the temperature, it is still use analog thermometer.[1]

In our proposed method, we use contactless temperature sensor MLX90614 based on infrared to measure the temperature at the chemical solvent. We use magnetic bar

stirrer that moved by DC motor to mix the chemical solvent. PID controller is used to control the DC motor speed according to the desired velocity set point based on constant value K_p , K_i , and K_d . This device is equipped with manual and automatic mode. If automatic mode is selected then choose the desired solvent. If manual mode is selected then set the temperature (30-60° celcius), stirring velocity (400-1600 rpm) and stirring time (1-30 minute) which can be seen at LCD display.

II. PREVIOUS RESEARCH

Design *hotplate* is equipped with a heater driver to detect the temperature on the *heater* is placed on the *plate*. And it is equipped with ansensor *infrared thermo* that can measure the temperature of the heated solution without direct contact with the solution, making it easier for the laboratory to measure the temperature of the solution without using *thermometer*.

Isti'ah ira (2017)[2] in a study on "Design of *Magnetic Stirrer Hotplate* Based on Atmega8 Microcontroller". In this study the *hotplate* is equipped with a temperature control and rotational speed which is set by pressing the button *up* or *down* but for this determination it is not equipped with an automatic thermometer that can measure the temperature changes directly in the solution.

Irsyad Lalu Patria, Yudianingsih and Sri Lestari (2016)[3] in a study titled "Design Tools Magnetic Stirrer speed settings with the Sitter And the stirring time management". On the research for motor torque stirrer as sebaiknya using higher so that when the motor gets the load then the motor speed will be relatively stable.

Jecson Steven Daniel Zebua, Mas Sarwoko Suraatmadja, Ahmad Qurthobi (2016)[4] in a study entitled "Design of Digital Thermometers without Touch" this tool uses the MLX90614 sensor to read the best insurance temperature when reading the temperature at a distance of 15 cm in an open space.

In a "modul *magnetic stirrer hotplate*" that already exist must use a *thermometer* to measure the temperature of the heated solution. therefore surveyors laid out *hotplate* that is

capable of measuring the temperature of the heated solution by using sensor *MLX90614 infrared* without direct contact with the solution, another advantage on the Tools menu, there is an automatic and a manual for mixing the solution.

III. DESIGN OF THE CONTROL SYSTEM

Our research method is consist of hardware design and software design using CVAVR (Code Vision AVR) IDE

A. Mechanical Design

The mechanical design of the magnetic stirrer hot plate consists of several parts and the most important part is a heater. Heater is used to heat the chemical solvent. For more details, see Fig 1

From Fig 1 the magnetic stirrer hot plate mechanical design is shown which consists of the following parts:

1. Contactless infrared *MLX90614* temperature sensor is used to detect the solvent temperature.
2. Temperature sensor holder.
3. Hot plate is made from stainless steel.
4. Heat reducer is made to maintain all of hot plate components from the heat.
5. LCD display is attached to show the setting and current value of parameters.
6. LED as system indicator.
7. Up button is used to increase the temperature, velocity and timer setting.
8. Set button is used to enter the setting mode.
9. Start button is used to start the device when all value has been set.
10. Reset button is used to reset all the setting or restart if the failure occur
11. On/Off button is used to activate and deactivate the device.

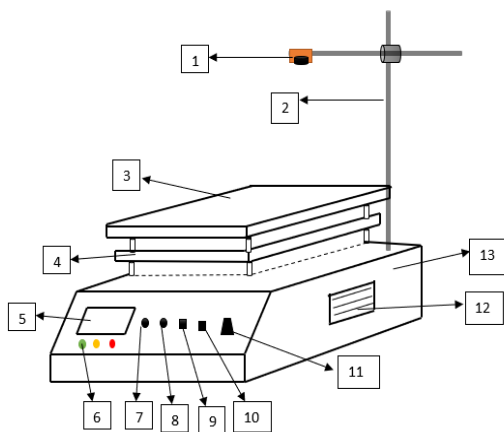


Fig. 1. Mechanical Design Of Magnetic Stirrer Hot Plate



Fig. 2. Mechanical Design Implementation of Magnetic Stirrer Hot Plate

B. Electrical Block Diagram

In this research, a magnetic stirrer hot plate has been designed to heat and stir a solvent both manually and automatically. Figure 3 shows the block process diagram of the system based on the magnetic stirrer hot plate;

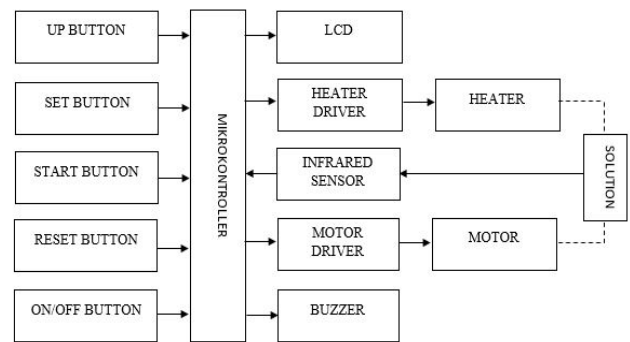


Fig. 3. Electrical Block Diagram Of Magnetic Stirrer Hot Plate

C. Hardware Implementation

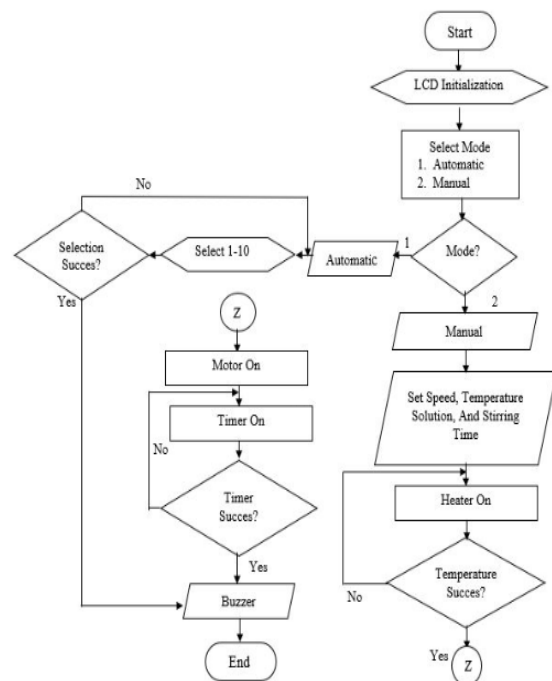


Fig. 4. System Flowchart

From the figure above our magnetic stirrer hot plate has been equipped with contactless infrared sensor MLX90614 to detect temperature at chemical solvent. The microcontroller software process will be described below:

The first process is initialization that enables us to choose the mode both automatic and manual mode. If automatic mode is selected then choose the desired solvent, there are 10 samples of mixing solvent data, and push the start button then wait until finish. If manual mode is selected then set the temperature (30-60° Celsius), stirring velocity (400-1600 rpm) and stirring time. If the user has one of the listed mixing solvent data then user can choose it and wait until finish. Contactless infrared temperature sensor MLX90614 will always detect the solvent temperature. If the temperature has reached the desired value then heater will be turned off and DC motor and timer will be activated until the timer setting has been reached. Our proposed method use PID controller to stabilize the velocity of DC motor and solvent temperature as determined at set point value.

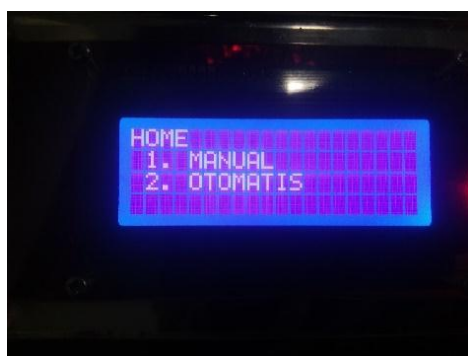


Fig. 5. System Mode



Fig. 6. Manual Mode



Fig. 7. Automatic Mode

TABLE I. CHEMICAL MIXING SOLVENT DATA
(Source: Astari, Fauziah, dkk. 2014. "Laporan Resmi Praktikum Kimia Dasar 1". Samarinda: Universitas Mulawarman) [7]

No.	Solution	Temperature	Rpm	Stirring time
1.	1) 1 liter cooking oil 2) 2.25 grams Methol 3) 0.05 gram Sulfuric Acid	65	400	2 minutes
2.	1) 400 ml of water 2) 50 grams of sugar	30	400	3 minutes
3.	1) 10 ml distilled water 2) 2 gram sucrose	45	400	2 minutes
4.	1) 50 ml distilled water 2) Ca (OH) ₂ 1 gram	40	400	10 minutes
5.	1) 50 grams of bulk sugar 2) Iodine salt 50 grams 3) 400 ml tap water	40	800	5 minutes
6.	1) 1 liter of fried coconut oil 2) 2.25 grams of methol 3) 0.05 grams of sulfuric acid	60	400	2 hours
7.	1) aquadest 50 ml 2) sand	-	800	-
8.	1) aquadest 50 ml 2) chalk	-	800	-
9.	1) 10 ml methanol 2) Tap water 200 ml	40	400	5 minutes
10.	1) 10 ml ethanol 2) 50 grams starch 3) 400 ml tap water	40	800	-

IV. PID CONTROL THEORY AND TUNNING ALGORITHM

The development of PID control theories has already 60 years ago, PID control has been one of the control system design method of the longest history. However, this method is still extensively used now. The structure of PID controller is simple; it is the most extensive control method to be used in industry so far. The PID controller is mainly to adjust an appropriate proportional gain (K_p), integral gain (K_i), and differential gain (K_d) to achieve the optimal control performance. The PID controller system block diagram of this paper is shown in Figure 1

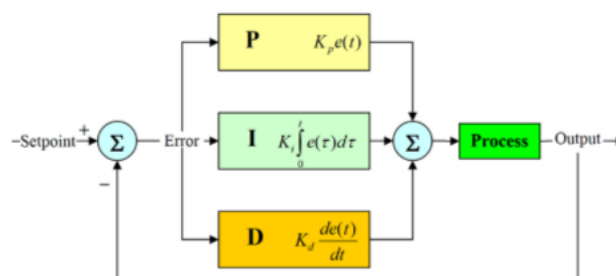


Fig. 8. PID Controller System Block Diagram.

The relationship between the input $e(t)$ and output $u(t)$ can be formulated in the following,

$$U(t) = K_p e(t) + K_t \int_0^t e(t) dt + K_p \frac{de(t)}{dt}$$

The transfer function is expressed as follows

$$C(s) = K_p + \frac{K_I}{s} + K_d s = \frac{U(s)}{E(s)}$$

The DC motor speed control using Close loop PID controller system block diagram is shown in Figure 2

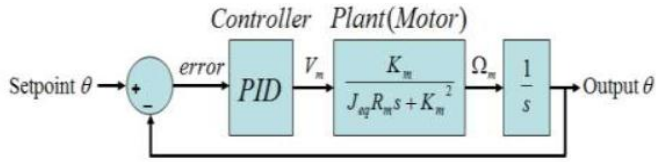


Fig. 9. Close Loop PID DC Motor Speed Control System Block Diagram

Ziegler Nichols Method (Closed-loop) is a type of continuous cycling method for controller tuning. The term continuous cycling refers to a continuous oscillation with constant amplitude and is based on the trial-and-error procedure of changing the proportional gain (K_p). (K_p) is reduced from larger value till the point at which the system goes to unstable state i.e. the point at which the continuous oscillations occurs. Thus the gain at which system starts oscillating is noted as ultimate gain (K_u) and period of oscillations is ultimate time period (K_u). It allows us to use the ultimate gain value, (K_u), and the ultimate period of oscillation (P_u) to calculate (K_c). These two parameters, (K_u) and (P_u) are used to find the loop-tuning constants of the controller (P, PI, or PID) using the formula tabulated in Table 2.[5]

TABLE II. ZIEGLER NICHOLS PARAMETERS

Controller	K_p	T_I	T_D
P	$0.5 K_u$	∞	0
PI	$0.4 K_u$	$\frac{P_u}{1.2}$	
PID	$0.6 K_u$	$\frac{P_u}{2}$	$\frac{P_u}{8}$

The advantage of this method is that it is a proven online method and includes dynamics of whole process, which gives a more accurate picture of how the system is behaving. The disadvantage is that it up sets the process, uses trial and error method and has a very aggressive tuning. This closed-loop tuning method is limited to tuning processes that cannot run in an open-loop environment.

V. SIMULATION AND ANALYSIS OF THE SYSTEM

The experiment was carried out to determine the conditions and results of the magnetic stirrer hot plate. Testing was also conducted to determine the speed precision

D. PID Tuning Experiment

One of the motor speed controller method is by using PWM (Pulse Width Modulation), by changing duty cycle value so the motor speed will be changed as well [6]. This experiment

purpose is to implement PID method in order to minimize the error of desired speed. In this experiment, the velocity is 400 rpm and the PID constants are tuned manually by using Zeiger and Nichols rule. In this rule, there are the value of K_p is set from 0 to a specific value until $K_u = 461.0$ and $P_u = 3$ as shown in the table below:

TABLE III. PID PARAMETERS VALUE WITH ZEIGER-NICHOLS METHOD

Controller Type	K_p	T_I	T_D
P	$0.5 K_u$ $0.5 \cdot 461 = 230.5$	∞	0
PI	$0.45 K_u$ $0.45 \cdot 461 = 207.45$	$0.5 P_u = 1.5$	0
PID	$0.6 K_u$ $0.6 \cdot 461 = 276.6$	$0.5 P_u$ $0.5 \cdot 3 = 1.5$	$0.125 P_u$ $0.125 \cdot 3 = 0.375$

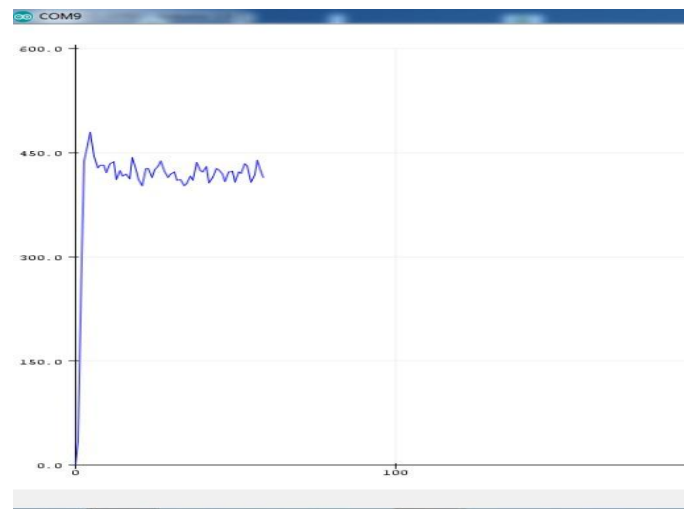


Fig. 10. PID Tuning with Zeiger-Nichols Method

E. DC Motor Speed Measurement

In this measurement, we use tachometer DT-2234C to measure the velocity of DC motor. The result is shown in the table below:

TABLE IV. VELOCITY EXPERIMENT

No.	Velocity (rpm)			
	400	800	1200	1600
1	407,7	798,6	1213,8	1594,0
2	402,0	801,4	1200,0	1592,0
3	403,8	802,8	1202,0	1595,0
4	400,2	803,0	1200,0	1598,0
5	408,0	802,0	1201,0	1601,0
Mean	404.34	801.56	1203.36	1596,0
Deviation	4.34	1.56	3.36	4
Error	1.085%	0.195%	0.28%	0.25%

Statistical analysis is shown below:

$$1. \text{Mean}(X) = \frac{\sum x_n}{n}$$

$$X = \frac{407,7 + 402 + 403,8 + 400,2 + 408,0}{5}$$

$$X = 404,34$$

2. Deviation= setting data– \bar{X}
Deviation =400 – 404,34
Deviation =-4,34
3. $\% \text{ error} = \frac{\text{setting data} - \bar{X}}{\text{setting data}} \times 100\%$
 $\% \text{ error} = \frac{-4,34}{400} \times 100\%$
 $\% \text{ error} = -1,085\%$

From the experiment, we got error = 1.085% for 400 rpm, error = 0.195% for 800 rpm, error = 0.28% for 1200 rpm, and error = 0.25% for 1600 rpm. The highest error is at 400 rpm and the lowest one is 800 rpm

F. Temperature Measurement

In this measurement, we use digital thermometer TP101 and put temperature sensor MLX90614 at 3 cm above the glass. The result is shown in the table below:

TABLE V. TEMPERATURE EXPERIMENT

No.	Temperature (C)			
	30	40	50	60
1	30.1	40.5	50.1	60.6
2	29.8	40.1	50.1	60.2
3	29.9	39.9	50.2	60.5
4	30.0	39.7	50.5	59.2
5	30.6	39.6	50.2	60.5
Mean	29.40	39.96	50.22	60.4
Deviation	0.6	0.04	0.22	0.4
Error	2%	0.1%	0.44%	1%

Statistical analysis is shown below:

1. $Mean(X) = \frac{\sum x_n}{n}$
 $X = \frac{30,1 + 29,8 + 29,9 + 30,0 + 30,6}{5}$
 $X = 29,40$
2. Deviation= Setting data– \bar{X}
Deviation =30 – 29.40
Deviation =0,6
3. $\% \text{ error} = \frac{\text{setting data} - \bar{X}}{\text{setting data}} \times 100\%$
 $\% \text{ error} = \frac{0,6}{30} \times 100\%$
 $\% \text{ error} = 2\%$

In this experiment, we got error = 2% for 30° C, error = 0.1% for 40° C, error = 0.44% for 50° C, and error = 1% for 60° C. The highest error is at 30° C and the lowest one is 40° C

VI. CONCLUSION

Based on the results of the design, implementation and testing of the system that has been made, the following conclusions can be drawn:

1. From trial, the value Kp= 0,03, Ki= 0.000001, and Kd= 0.000012 and motor rpm is more stable even though there is still error 1,085%.
2. Error tolerance testing ranges between 2%-5%, from the results of the rpm test, it is obtained the highest error 1,085% that is still categorized as good because it is still in the range of tolerance.

3. During temperature testing, it is obtained the highest error at a temperature 30 with the error 2% which is in good categories.

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Optimizing Process Parameter Machining From Combined Energy Consumption and Material Removal Rate On ST 41-3

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Abstract— Machining processes are spent a lot of energy in the manufacturing industry. On the other hand, we understand that energy should be minimum. The purpose of this study is to find the optimal machining parameters that allow the most energy-efficient processes. The study focused on optimization of parametric process machining on combination energy consumption and material removal rate in machining on Steel ST 41-3. The data were evaluated using the Taguchi method and TOPSIS (Technique for Order Preference by Similarity to Ideal Solution). Finally, the research has successfully to get the best parameter of machining are cutting speed of 22.8 (mm / min), feeds (0.01 mm/tooth) and the depth of cuts (1.5 mm). At the parameter machining setting have the lowest energy used level. Experiments in this study will be carried out in a laboratory scale, and the results of these experiments can be used as a reference in its application in the industrial world.

Keywords—Parameter Machining; Energy Consumption; Material Removal Rate; Taguchi; TOPSIS.

I. INTRODUCTION

In the last few years, efficiencies energy is a big issue in manufacturing processes. Because the most cost in manufacturing processes comes from energy consumption. Material Removal Rate (MRR) is an important aspect of the machining process to be optimized [1]. MRR has an important influence on productivity of a manufacturing industry, especially in the metal cutting process (the metal cutting process becomes vital) in the rouging stage (rough cultivation stage before finishing) [2]. [3] Optimizing energy consumption and MRR can improve the efficiency of machining processes in the manufacturing industry.

Optimization of energy consumption and MRR responses will be carried out by determining the optimal value of machining parameters that affect both responses. Machining parameters (factors) used include cutting speed, feed, and depth of cut [4]. In this study, a combination of Taguchi method and TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) is used to determining the optimal value of machining parameters. Experiments in this study will

be carried out in a laboratory scale, then the results of these experiments can be used as a reference in its application in the industrial world. Taguchi method [5] is a method of optimizing single response process parameters. [6] The Taguchi method can provide optimal results with a number of more efficient trials. The use of TOPSIS method in this study is used to complete the determination of a combination of factor levels that can provide the most optimal results for the response (energy consumption and MRR).

II. LITERATURE REVIEW

A. Material Removal Rate (MRR)

Material Removal Rate is one indicator that can be used to measure the performance of the machining process [8]. MRR which is defined as the amount of material volume wasted per unit of time [9] is influenced by several parameters. These parameters are cutting speed (v), feed (z), and depth of cut (d) [5] [6].

$$v = \frac{\pi \cdot d \cdot n}{1000} \quad (1)$$

$$v_f = f_z \cdot n \cdot z \quad (2)$$

$$MRR = \frac{d \cdot w \cdot v_f}{1000} \quad (3)$$

Where,

z = tooth	v = cutting speed (m/min)
D = diameter (mm)	v_f = feed (mm/min)
n = RPM	f_z = feed (mm/tooth)
w = width (mm)	d = depth of cut (mm)

III. METHODS

A. Taguchi Method

Taguchi method is an orthogonal matrix design that is used to analyze parameters with little experiment. The optimal level process value is the level that has the highest relationship.

Furthermore, through ANOVA analysis can find out which process parameters are important optimal and efficient results with relatively easy applications [8].

B. Technique for Order Preference by Similarity to Ideal Solution (TOPSIS)

TOPSIS is one method of Multiple Criteria Decision Making (MCDM). The principle of the TOPSIS method is that the chosen alternative must have the shortest distance from the positive solution or the negative solution from a geometric point of view [3].

C. Tools and Material

1. HSS Endmill

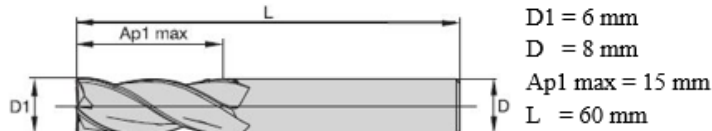


Fig. 1. Figure 1. HSS Endmill [12]

2. CNC ProMill 8000



Fig. 2. Figure 2. CNC ProMill 8000 [10]

3. ST 41-3

ST 41-3 is one type of material that is often used in the industrial world. The use of ST 41-3 is mainly used in making bars, plates, structural shapes, axles, connecting rods, shafting etc [11].

4. Power Meter Hioki 3286-20



Fig 3. Power Meter Hioki 3286-20 [12]

IV. RESULTS AND DISCUSSION

TABLE I. LEVEL COMBINATION OF MACHINING PARAMETER PROCESS

No	Machining Parameter Process	Level 1 (1)	Level 2 (2)	Level 3 (3)
1	Cutting speed (v), m/min	22,8	33,9	45,0
2	feed (f_z), mm/tooth	0,0100	0,0125	0,0150
3	Dept of cut (d), mm	0,150	0,825	1,500

TABLE II. EXPERIMENT DATA

No	Treatment Factor code			Repetition 1	
	v	f_z	d	$W_{cutting}$ (Wh)	MRR (Vol/min)
1	1	1	1	5,88	43,3929
2	1	2	2	6,0919	293,7363
3	1	3	3	5,0875	656,7568
4	2	1	2	4,8958	356,4
5	2	2	3	4,3333	810
6	2	3	1	2,5764	87,2
7	3	1	3	5,2603	852,6316
8	3	2	1	2,625	108
9	3	3	2	3,2406	703,4211

A. ANOVA Consumption Energy

Steps taken to identify factors that significantly influence the response variable. This is done on the average of the response variables (energy consumption and MRR) in the milling process that arises due to treatment factors. In this ANOVA test the error value (α) is 5%. Here are the hypotheses used.

a. Effect of cutting speed (v)

H0 = There is no significant effect of cutting speed factor (v) on energy consumption

H1 = There is a significant effect of cutting speed factor (v) on energy consumption

b. Influence effect (f_z)

H0 = There is no significant effect of feed factor (f_z) on energy consumption

H1 = There is a significant influence of the feed factor (f_z) on energy consumption

c. Effect of cutting depth (d)

H0 = There is no significant influence from the cutting depth factor (d) on energy consumption

H1 = There is a significant influence from the cutting depth factor (d) on energy consumption

If $F_{count} > F_{table}$: Reject H0 or $F_{count} \leq F_{table}$: Accept H0

TABLE III. ANOVA MEAN ENERGY CONSUMPTION

Source	DF	SS	MS	F-VALUE	PC
v	2	5,45	2,7	89,59	40,31%
fz	2	4,02	2	66,055	29,60%
d	2	3,84	1,9	63,139	28,27%
Error	2	0,06	0		1,82%
Total	8				100%

Based on the percentage contribution (PC) in table III it can be seen that the cutting speed factor (40.308%) has the greatest influence.

TABLE IV. TUKEY TEST FACTOR VS ENERGY CONSUMPTION

	Cutting Speed			Feed			Depth of cut		
Level	1	2	3	1	2	3	1	2	3
N	3	3	3	3	3	3	3	3	3
Mean	5,56	4,08	3,778	5,4	4,31	3,8	5	5	3,57
Grouping	A	B	B	A	B	B	B	A	A

B. ANOVA Material Removal Rate

This ANOVA test aims to find the treatment factors (cutting speed, in feed and cutting depth) which significantly affect the material removal rate. In this ANOVA test the error value (α) is 5%. Here are the hypotheses used.

a. Effect of cutting speed (v)

H0 = There is no significant effect of the cutting speed factor (v) on the material removal rate

H1 = There is a significant effect of the cutting speed factor (v) on the material removal rate

b. Influence effect (fz)

H0 = There is no significant effect of feed factor (fz) on the material removal rate

H1 = There is a significant effect of feed factor (fz) on material removal rate

c. Effect of cutting depth (d)

H0 = There is no significant effect of the cutting depth factor (d) on the material removal rate

H1 = There is a significant influence from the cutting depth factor (d) on the material removal rate

If $F_{count} > F_{table}$: Reject H0 or $F_{count} \leq F_{table}$: A

TABLE V. ANOVA MEAN MATERIAL REMOVAL RATE

Source	DF	SS	MS	F-VALUE	PC
v	2	75032	37516	2,21	
fz	2	11818	5909	0,348	
d	2	707935	4E+05	20.851	81,33%
Error	2	33951	16976		18,67%
Total	8	828737			100%

The conclusion of these results is that there is a significant effect of the cutting depth factor on the average MRR value.

TABLE VI. TUKEY TEST VS MRR

Depth of cut	N	Mean	Grouping	
3	3	769,048	A	
2	3	450,506	A	B
1	3	82,647		B

The difference between the third and the first level shows the use of the second level will result in a significant difference in MRR values.

C. Calculation of S/N Matrics Ratio, Norm dan Weight Matrics

TABLE VII. S/N MATRICS RATIO, NORM AND WEIGHT MATRICS

No	Data S/N Ratio		Norm Matrix		Weight Matrix	
	<i>E cutting</i>	<i>MRR</i>	<i>E cutting</i>	<i>MRR</i>	<i>E cutting</i>	<i>MRR</i>
n1	-14,8893	32,7742	0,3841	0,2182	0,5624	0,3218
n2	-15,2149	493,909	0,3925	0,3288	0,5747	0,4849
n3	-14,6302	56,3089	0,3775	0,3749	0,5526	0,5528
n4	-14,2179	50,9617	0,3393	0,3393	0,537	0,5003
n5	-13,1495	58,1213	0,387	0,387	0,4967	0,5706
n6	-8,1812	39,7533	0,2647	0,2647	0,309	0,393
n7	-14,6672	58,5643	0,3899	0,3899	0,554	0,575
n8	-8,3516	40,6039	0,2703	0,2703	0,3155	0,3986
n9	-10,4012	56,9443	0,3791	0,3791	0,3929	0,5591
max					0,5747	0,575
min					0,309	0,3218

In this ANOVA test the error value (α) is 5%. Here are the hypotheses used.

a. Effect of cutting speed (v)

H0 = There is no significant effect of cutting speed factor (v) on energy consumption

H1 = There is a significant effect of cutting speed factor (v) on energy consumption

b. Influence effect (fz)

H0 = There is no significant effect of feed factor (fz) on energy consumption

H1 = There is a significant influence of the feed factor (fz) on energy consumption

c. Effect of cutting depth (d)

H0 = There is no significant influence from the cutting depth factor (d) on energy consumption

H1 = There is a significant influence from the cutting depth factor (d) on energy consumption

If $F_{count} > F_{table}$: Reject H0 or $F_{count} \leq F_{table}$: Accept H0

TABLE VIII. ANOVA S/N MATRICS RATIO CONSUMPTION ENERGY

Source	DF	SS	MS	F-VALUE	PC
v	2	24,103	12,051	89,428	36,23%
fz	2	19,294	9,647	71,586	28,92%
d	2	22,126	11,063	82,092	33,22%
Error	2	0,27	0,1348		1,64%
Total	8	65,792			100%

Based on this, it can be concluded that there is a significant effect of all treatment factors on the average response value of energy consumption.

TABLE IX. TUKEY TEST FACTOR VS S/N MATRICS RATIO CONSUMPTION ENERGY

	Level	N	Mean	Grouping
Cutting Speed	1	3	-14,9	B
	2	3	-11,9	A
	3	3	-11,1	A
Feed	1	3	-14,6	B
	2	3	-12,2	A
	3	3	-11,1	A
Depth of cut	1	3	-10,5	B
	2	3	-13,3	A
	3	3	-14,1	A

D. ANOVA Material Removal Rate

In the ANOVA test, the current error value (α) is 5%. The following is the original statement.

A. Key cutting speed (v)

H0 = There is no significant factor of cutting speed factor (v) on the level of material removal

H1 = there is a significant effect of cutting speed factor (v) on the rate of material removal

b. Influence effect (fz)

H0 = There is no significant factor of feed factor (fz) on material removal rate

H1 = significant influence of infeed factor (fz) on the level of material removal

c. Cutting depth measurement (d)

H0 = There is no significant factor from the cutting depth factor (d) to the rate of material removal

H1 = there is a significant influence from the cutting depth factor (d) on the rate of material removal

If $F_{count} > F_{table}$: Reject H0 or $F_{count} \leq F_{table}$: Accept H0

TABLE X. ANOVA S/N RATIO MATERIAL RMOVAL RATE

Source	DF	SS	MS	F-VALUE	PC
v	2	52,382	26,191	10251,75	7,34%
fz	2	19,152	9,576	3.748,220	2,68%
d	2	642,39	321,144	125.702,700	89,98%
Error	2	0,005	0,003		0,003%
Total	8	713,83			100%

In table X, it can be seen that the cutting depth factor has the greatest effect on changes in MRR variance values .

E. Tukey Test Factor Vs S/N Ratio MRR.

TABLE XI. ANOVA S/N RATIO MATERIAL REMOVAL RATE

	Level	N	Mean	Grouping
Cutting Speed	1	3	46,16	C
	2	3	49,61	B
	3	3	52,04	A
Feed	1	3	47,43	C
	2	3	49,372	B
	3	3	51	A
Depth of cut	1	3	37,71	C
	2	3	52,43	A
	3	3	57,67	A

F. Different in positive – negatif Ideal Solution and Overall Performance Indicators

TABLE XII. ANOVA S/N RATIO MATERIAL REMOVAL RATE

No	Combination			Si+	Si-	OPI
	v	fz	d			
1	1	1	1	0,2535	0,2534	0,4999
2	1	2	2	0,0901	0,3118	0,7759
3	1	3	3	0,0313	0,3357	0,7759
4	2	1	2	0,0836	0,2896	0,776
5	2	2	3	0,0781	0,3117	0,7996
6	2	3	1	0,3236	0,0685	0,1748
7	3	1	3	0,0207	0,3523	0,9445
8	3	2	1	0,3135	0,0771	0,1975
9	3	3	2	0,1825	0,2517	0,5796

G. Anova Test Combining The Response Of Energy Consumption And MRR

In this ANOVA test the error value (α) is 5%. Here are the hypotheses used.

a. Effect of cutting speed (v)

H0 = There is no significant effect of cutting speed factor (v) on energy consumption and MRR

H1 = There is a significant effect of cutting speed factor (v) on energy consumption and MRR

b. Influence effect (fz)

H0 = There is no significant effect of feed factor (fz) on energy consumption and MRR

H1 = There is a significant effect of infeed factors (fz) on energy consumption and MRR

c. Effect of cutting depth (d)

H0 = There is no significant influence from the cutting depth factor (d) on energy consumption and MRR

H1 = There is a significant influence from the cutting depth factor (d) on energy consumption and MRR

If $F_{count} > F_{table}$: Reject H0 or $F_{count} \leq F_{table}$: Accept H0

TABLE XIII. ANOVA COMBINE RESPONSE OF ENERGY CONSUMPTION AND MRR

Source	DF	SS	MS	F-VALUE	PC
v	2	0,046	0,023	1061,28	6,91%
fz	2	0,057	0,029	1.318,330	8,59%
d	2	0,562	0,281	12.948,630	84,46%
Error	2	0	0		0,03%
Total	8	0,665			100%

Based on the results of calculations in table XIII, it can be seen that the cutting depth factor has the greatest influence on the combination of energy consumption response and MRR. The magnitude of the effect of the depth of cut is indicated by the percentage contribution (PC) of 84.463%.

H. Tukey Test Significant Factors Combining The Response Of Energy Consumption And MRR

TABLE XIV. ANOVA COMBINE RESPONSE OF ENERGY CONSUMPTION AND MRR

	Level	N	Mean	Grouping
Cutting Speed	1	3	0,7302	A
	2	3	0,5834	B
	3	3	0,5739	B
Feed	1	3	0,7401	A
	2	3	0,5910	B
	3	3	0,5564	A
Depth of cut	1	3	0,291	C
	2	3	0,711	B
	3	3	0,886	A

I. The Best Level Combination

TABLE XV. THE BEST LEVEL COMBINATION FACTORS

Level	Cutting Speed (mm/min)	Feeds (mm/tooth)	Depth of cut (mm)
1	0,7302	0,7401	0,2907
2	0,5834	0,591	0,7105
3	5739	5564	0,8863

The best level of all factors with response rates from various levels. Based on the results of the response rate, the highest level is the first speed (22.8 mm / minute). The best level for feed factor is the first level (0.01 mm / tooth). The best level for depth factor is the third level (1.5 mm).

V. CONCLUSION AND FURTHER RESEARCH

The aim of the research was to develop machining parameters process with the lowest consumption energy. The machining parameters are cutting speed 22.8 mm/min, feed 0.01 mm/tooth and depth of cut 1.5 mm. Through this parameters it is expected that the cost of the production process will decrease. In this study the point of view is only the speed of the machining process for energy efficiency, especially the ST 41-3 steel material. Material differences will produce different parameters, so there are still many studies on other material machining processes.

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An Open Source Software Quality Model and Its Applicability for Assessing E-commerce Content Management Systems

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Abstract—Content Management Systems (CMS) are widely known to provide a simple and practical way to create and administer a web application including e-commerce. A variety of CMSs exist which offer different features needed to develop an e-commerce. Nonetheless, there is limited knowledge on what framework can guide the selection of appropriate CMS for building a quality e-commerce. This is timely since e-commerce has been inhabited by the fears and risks associated with the online business. Five CMS e-commerce (WP e-commerce, Woocommerce, VirtueMart, Prestashop, and OpenCart) were chosen, deployed, customised, hosted in an online server as case studies of e-commerce and then tested against the quality criteria and metrics. This study provided empirical evidence on the applicability of the proposed model for gaining insights into the quality of e-commerce CMS.

Keywords—Software quality model; Open Source Software; Content Management System; E-commerce

I. INTRODUCTION

In the last few years, e-commerce has been one of the major investments for business to gain competitive advantages such as reducing cost, expanding the market, and providing better services [1]. It is, therefore not surprising; many modern businesses are interested and motivated to adopt e-commerce. Nonetheless, in reality, setting up e-commerce is likely difficult endeavour before it could be fully implemented. Especially for newly established or small businesses whose core business is not IT based; there are obstacles to be overcome in developing such e-commerce. The literature has indicated that a shortage of skilled labour, technical issues and fear of involving additional cost for hardware or software investment are among the challenges that should be addressed [2, 3].

Apart from that, there are lots more challenges involved in running the newly established e-commerce which require priority attention. This is because running e-commerce is likely much more than just about developing or having an online website. But beyond that, there are such vast arrays of socio-technical considerations. Examples include maintaining the system, ensuring the security, monitoring the website's traffics, retaining costumers' loyalty as well as building their trust in terms of quality of products, payment

options and data privacy put on the web [4]. Therefore, failure in managing all of these issues properly can stop the e-commerce operation or even threaten the achievement of the goals.

With the current advancement in the web development approach using a Content Management System (CMS), the burden in building and sustaining an e-commerce likely can be minimised. This is because CMS provides all the features required to develop, set up an e-commerce and managing its content practically without the support from experts [5]. Additionally, since almost all of the CMSs are distributed under the open source platform, business will have the freedom to obtain, run, use and adapt them for developing e-commerce site without being charged licensing fee. Within the freedom principles, every CMS also comes with a community where anyone including businesses could either provide or seek necessary supports, assistance and feedback from others regarding particular issues.

All these benefits have made CMS become the most popular tool that offers conformity in building an e-commerce, yet powerful. According to statistics by Digital Guide [6], there exist numerous between 250 and 350 CMSs currently available in the community as standard solutions for professional web-store development. Nonetheless, not all CMSs are suitable to optimally support every business process. This is because CMSs comes with different variants and capability from a simple content to a complex framework for establishing an enterprise-wide system. Even if some CMSs have similar features, each of which however has its own characteristics, benefits, drawbacks and particular technical requirements in the implementation, installation, and configuration processes.

Based on the discussion above, it is clear that to identify and select an appropriate CMS for building a quality e-commerce is likely uneasy, especially for newly established or small businesses. Despite this challenge, there is limited knowledge on what quality model can be used to help businesses identify and select appropriate CMS that fits with their needs. Considering of this gap, this study aims to present quality model derived from existing standards which can be used for assessing CMSs. It then used the model to

assess the quality of e-commerce CMSs as empirical evidence.

II. LITERATURE REVIEW

A. Software Quality Models

One of central discussion in software development since the early time is how to build quality software. According to ISO 25010, the quality of the software is defined as *the degree to which the system satisfies the stated and implied needs of its various stakeholders and thus provides value* [7]. According to Behkamal-Kahani [8] ensuring adequate the quality of the software can be only achieved by defining appropriate quality characteristics

This, in particular, has triggered practitioners and academia such as McCall, Boehm, Grady and Hewlett-Packard Co to provide models that are useful for assessing software quality [9]. The need for software quality assurance has gained more and more attention due to demand to build software product which conforms to particular requirements. In addition, the increasing number of failures and delays in a software project has also fuelled the need to develop more quality models [10]. Since the models are made up of a different combination of attributes and rooted from diverse area, very often they make the confusion that potentially resulting in an unexpected or imprecise output.

An initiative was taken by the International Organization for Standardisation (ISO) to develop consensus for standardised software quality attributes and metrics. An ISO/IEC 9126 was established in 1985 which measured the software quality form three perspectives: internal, external and quality in use. In 2010, ISO replaced 9126 standards with ISO 15010 which extends the model by including computer systems, and quality in use from a system perspective [7] as depicted in Fig 1. One common criticism with this standard is that it makes no consideration or provision for evaluating Open Source Software (OSS) quality. Furthermore, as the standard is intended for commercial software, the attributes and the metrics did not factor in a unique characteristic of OSS such as freedom principles [11].



Fig. 1. ISO 25010 quality model

Review from the literature indicated a number of initiatives have been taken to define a quality model for OSS. Most of which are adapted from the ISO 9126 quality model with additional aspects on freedom principles of OSS [12]. However, the overall models provide generic quality attributes for OSS in general and make little consensus on the metrics used in the assessment. As a result, given the diverse nature of OSS packages, it is often difficult to apply the model for specific cases such as for assessing e-commerce Content Management System (CMS). Therefore, a more study that proposes a quality model and then demonstrates its applicability in evaluating e-commerce CMS quality in an empirical context is a warrant.

B. E-commerce CMS quality model

A CMS is defined as *a database of information and a way to change and display that information, without spending a lot of time dealing with the technical details of presentation*[13]. Using CMS, users without programming knowledge can create, edit, and publish web content, such as text or multimedia elements, collectively via a graphical user interface [6]. This conformity combined with the ease of use has clearly offered advantages and made CMS as most preferred choice especially for those a seeking practical way to build a web application.

Despite its popularity, CMS comes with lots of number of variances which on the other hand rise a major issues on how to discover the best suit one. The difficulty is likely to multiply since there are limited knowledge and no single criteria for guiding the selection of the CMS [14]. A number of studies have attempted to identify and examine the existing quality model for OSS [11, 15]. Other researchers have adopted and used the quality attributes and metrics provided by existing models for assessing the quality of open source software [16, 17].

However, in the era of digital transformation where individual or organisation seem to make their business go online, researches on examining the quality of CMS especially used for developing e-commerce are still lacking. One exception [18] found which compared three e-commerce CMSs. However, the authors did make clear what quality model used in the study. With regards to the gaps discussed above, this study therefore aimed at presenting quality model derived from existing standards which can be used for assessing e-commerce CMS. To demonstrate the usefulness of the model, it was then used for gaining insights into the quality of some e-commerce CMSs in an empirical setting.

III. RESEARCH APPROACH

This study applied two research strategies lasted nearly six months to address the research problem. Firstly, a quality model for assessing e-commerce was proposed derived from existing criteria. Secondly, this study then employed the model to assess five e-commerce CMSs to demonstrate its usefulness as discussed below.

A. Defining quality model of e-commerce CMS

This study adopted the ISO 25010 model (see Fig 1) as an overarching framework that guided the development of e-commerce quality model. The ISO 25010 was chosen because this is most widely adopted series of quality standards. It also has great influence to the existing quality models in practices including the majority of OSS quality models that exist today [11, 12]. Nonetheless, not all of the characteristics are likely applicable for measuring the quality of all types of software products including e-commerce CMS packages as pointed out in the previous critiques. For instance, health and safety risk mitigation characteristic is usually more applicable for assessing the quality of human-computer system rather than software product including e-commerce application. For this reason, this study did not include this sub-characteristic as the measurement.

Through checking the list of ISO 25010 high-level quality characteristics and related sub-characteristics only some parts are included in this study due to their relevancy on the open source software principles (e.g. freedom to use, adapt, modify and share). More specifically to enable the quality assessment, a number of methods were proposed in Table 1 below.

TABLE I. E-COMMERCE CMSEVALUATION MODEL

Quality requirements	Quality Characteristics	Testing strategies (approach, method or tool)
Freedom principles	Economic risk mitigation	Online checker: Google Trend
Ease of deployment	Compatibility	Dynamic Testing
	Portability	Blackbox testing: browsers
	Maintainability	Dynamic Testing
System performance	Reliability	Online Stress testing: Webserver Stress Tool (WAPT 8.1.)
	Efficiency	Online web scanner: Pingdom Tool
Control of access	Security	Software as a Service (SaaS): Sucuri Sitecheck, white box and dynamic testing

B. Running quality assessment using proposed model

Following the development of the quality model, the next step was running quality assessment as suggested in the previous work [19]. At this stage, Five CMS e-commerce (WP e-commerce, Woocommerce, VirtueMart Prestashop and OpenCart) were chosen, deployed, customised, hosted in an online server as case studies of e-commerce and then tested against the quality criteria defined in Table 1. During this phase, the key quality attributes of the five e-commerce websites were examined using the following approaches:

- White Box testing (Internal inspection) was done by analysing the software properties including the documentation, manual, source code, database and features that have an impact on software behaviour.
- Dynamic and Black box testing (External inspection) was done by either using software or executing the

software and then measuring the dynamic attributes such as related to the behaviour of certain function and number of faults present in the program.

- Quality in use inspection was done similarly with external inspection but in a realistic context of use such as how users carrying out specific tasks

IV. RESULTS AND ANALYSIS

To start assess e-commerce CMS quality, a number of e-commerce CMS candidates was identified. Following the "Generally Recognized as Mature" (GRAM) principles [20], this study chose five e-commerce CMS and set up these into fully functioning online store applications (see Table II). Using the set criteria defined in Section III, all the applications were then evaluated in-depth.

TABLE II. FIVE E-COMMERCE CMS

No	E-commerce CMS	Hosted URL
1	WP e-commerce	http://istanasport.16mb.com/
2	Woocommerce	http://www.woocom.16mb.com/
3	VirtueMart	http://joomla-dev.hol.es/
4	Prestashop	http://gayaku.16mb.com
5	OpenCart	elektronikshop.000webhostapp.com

A. Freedom principles

One preliminary step prior to deploying an OSS is to ensure that the software complies with the freedom principle. Using the proposed model above, this corresponds to the *economic risk mitigation* quality characteristic that measures the ability of a software product in mitigating "the potential risk to financial status, efficient operation, commercial property, reputation or other resources in the intended contexts of use" [7]. This requirement, in particular, is reflected in open source licenses that allow the software to be freely obtained, used, distributed and modified at no cost.

Therefore, a basic way to evaluate the economic risk that arises from the OSS use is to read and review the license prior to installation. The review indicates that all five CMS packages investigated in this study use the GNU General Public License (GPL) that gives the freedom to copy, redistribute, understand, and modify the program. This finding, while primarily, suggests that all the software meet the quality requirement of e-commerce CMS.

Unfortunately, this basic assessment does not offer in-depth into the quality of the software which later could provide practical knowledge for selecting the appropriate e-commerce CMS. One way is to read the comments and reviews of the online support forum where problems and issues are discussed and resolved by OSS developers and other users. Therefore, the more popular forum is, the more likely the OSS offers fewer risks. This is because a popular support forum makes it likely easy for users to notice and resolve problems associated with the deployment process.

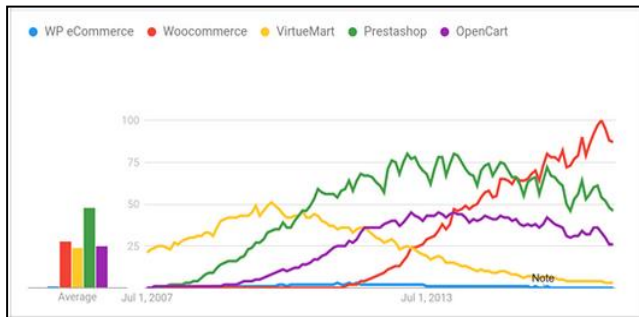


Fig. 2. Trends of five e-commerce CMS from 2007 to 2017

Nonetheless, reading and review support forums to compare and identify a quality OSS can be quite time-consuming. There are some measurements tools that can help compare different product being considered. An example is Google Trend which could provide a useful metric of and help determine whether a product is increasing or decreasing in popularity. Figure 2 illustrates the popularity and trendiness of five OSS using Google Trend in the last ten years that shows the most popular CMS is Prestashop then followed by Woocommerce, OpenCart, VirtueMart and WP Commerce respectively. In general, this means that overall Prestashop offers better quality assurance in risk mitigation compared to other CMSs.

Another interesting finding is that in the last five years, Woocommerce is the only CMS that has gained positive trend of increasing its popularity. This finding suggests that those who are looking for better CMS to develop their online store can use Woocommerce. This is contrary to what VirtueMart that has experienced declining its popularity consistently. This observed decline in popularity could be related to the difficulties encountered by users in getting support from the forum to fix their problems themselves when deploying the CMS. This declining may be partly related to the developers' approaches which tend to make the users to pay especially for higher and complex technical supports instead of the online forum. Finally, Figure 2 also shows an unexpected finding of the very low popularity of WP commerce or even zero. It is difficult to explain this finding, but it might be related to the decision of the developer not to allow their forums to be indexed by Google which then affects to the result of the Google Trend.

B. Ease of deployment

Despite the freedom principle, the other reason why users need to consider before adopting the CMS is the ease of deployment especially when it comes to installation, set up configuration and applying related modules [21]. Based on the model above, this requirement positively affects the quality of OSS and can be assessed in depth using some criteria as discussed below.

1) Compatibility

ISO 25010 defines portability as "the degree of effectiveness and efficiency with which a system, product or component can be transferred from one hardware, software or other operational or usage environment to another"[7]. The objective of portability assessment is to see if the

software can be successfully installed in a specified environment (installability). For this purpose, all five CMSs were installed in both local computer and web hosting account and then verified to see whether installation under different environment condition was free from failure. The investigation showed that all the CMSs can be installed successfully both on the local server and hosting service (see Table II).

2) Portability

The objective of portability assessment is to see how the software can be "adapted for different specified environments without applying components, actions or means other than those provided" [7]. For this purpose, each of the newly-installed CMSs was then set-up into a fully functional e-commerce store by running basic configuration, customising the theme and installing add-on modules required for the suitability and operability of an online store (e.g. payment, shipping and logistics). Finally, to see the portability performance, a different type of browsers (chrome, IE and Mozilla) were used to test the consistency of the website. Results indicated all the website can be best viewed in all browser platforms without failure except Wp e-commerce where the slider did not work well.

3) Maintainability

Maintainability assessment is aimed at defining how easy a software product can be modified for enhancements, corrective problems and adapting to changing needs. According to ISO 25010, the modification can include updating or upgrading the existing system (modifiability); module correction or even developing own component to suit with specific needs (modularity). One way employed in this study to determine the level of maintainability was by using a dynamic test that aimed to determine the ability of the forms interfaces in handling error detection and recovery. Analysis from dynamic testings showed all the form entries provided by the CMSs have error detection and recovery mechanisms such as highlighted incorrect entries, data consistency validation and feedback messages for further correction. Figure 3 shows an example of error detection and recovery mechanism.

Fig. 3. Result on error prevention & recovery mechanisms testing

C. System Performance

System performance is considered as the capability of the CMS accomplishes its designated functions within various constraints such as speed, accuracy, and

completeness [7]. As proposed in Table 1, two quality attribute will be checked to determine the performance level. First, each CMS was checked for its reliability associated with the number of failures occurred in specific time, number of defects which could cause incorrect operation and data loss. For this purpose, stress testing approach was employed to identify faults using the Web Stress Tool (WAPT 8.1). Table 3 summarises the results of the web stress tool of five CMSs run in 10 minutes involving 20 users. The evaluation was repeated in the next day to provide more accurate results. It can be seen from the Table 3, WP, Woocommerce, and VirtueMart are considered to have excellent reliability. Whereas Prestashop and OpenCart have reliability issues especially Prestashop.

TABLE III. RESULT FROM WEB STRESS TOOL (WAPT 8.1)

No	E-commerce CMS	Number of errors		Average
		Day 1	Day 2	
1	WP e-commerce	0	0	0
2	Woocommerce	0	0	0
3	VirtueMart	0	0	0
4	Prestashop	101	100	100
5	OpenCart	2	78	40

Second, this study also needed to assess the efficiency of each CMS. According to ISO 25010, the efficiency is considered as the number of resources required by each CMS to perform a specific function. For this purpose, Pingdom (<https://www.pingdom.com/>), an online website scanner services, was used to help gain instant and real-time insights into each CMS' performance. Analysis from the performance testing using Pingdom indicated that almost all CMSs' performances are considered as grade B (Good) except Prestashop that was found to be poor with grade D (67%).

This unexpected finding could be attributed by the slow load time of the website. Another possible explanation for this might be the poor service of Leverage Browser Caching with grade F as shown in Figure 4. This service enables a browser to store all static files required to load a website. Therefore, with such poor or unavailable cache services, the users' browser would download and retrieve all the files again from the servers which in particular made the loading speed longer.

D. Control of access

Another important quality attribute for a e-commerce CMS is security. ISO 25010 defines this as the ability of the system to provide required functionalities that ensure confidentiality, prevent unauthorised access to, or modification of and protect data and information. As mentioned in Table 1, two approaches were employed in this study to check the security level. First, using online SaaS, called Sucuri SiteChek, each CMS web-store was scanned to identify various security risks, vulnerabilities and

possible threats that can potentially harm or damage both the system and data. Examples included malware, anomaly injection, website blacklisting and Outdated.

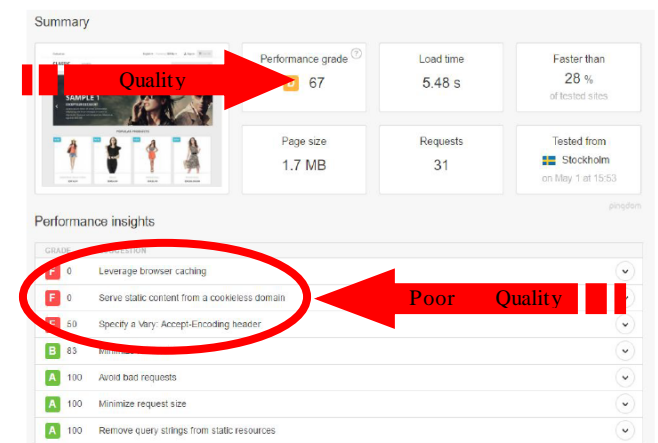


Fig. 4. Example of realtime performance test using pingdom

Table IV summarised the result of security test using Sucuri SiteChek. As can be seen from Table, it is clear that the web-store generated using OpenCart CMS has the lowest security risk. In the other hand, based on the test the web-store developed using PrestaShop and WP e-commerce was potentially have security issues on web blacklisting and outdated respectively. Another interesting finding was that almost all CMSs except OpenCart were detected to have an issue on website firewall security. This finding suggests that the need to provide additional layer of protection when developing web-store using those CMSs to ensure to prevent destructive forces and threats.

TABLE IV. SECURITY ISSUES

Security issues	CMS Commerce				
	WP	Woo	Vir	Pres	Open
Malware	Low	Low	Low	Low	Low
Web Blacklisting	Low	Low	Low	High	Low
Website Firewall	Med	Med	Med	Med	Low
Website Outdated	High	Low	Low	Low	Low
Injected spam	Low	Low	Low	Low	Low
defacement	Low	Low	Low	Low	Low

Despite using SaaS to scan the overall security issues, this study also needs to examine the data security. This is critical as the e-commerce is supposed to have the ability in ensuring confidentiality, preventing illegal access to, or modification of and protect data and information using various techniques. One technique was using white box testing in which the each CMS's DBMS was examined in term of relational, performing query (add data, insert data, update data, select data, view data and delete data) for each table and check data structure consistency. To test the data security, functional testing was conducted to examine form interfaces using various data training.

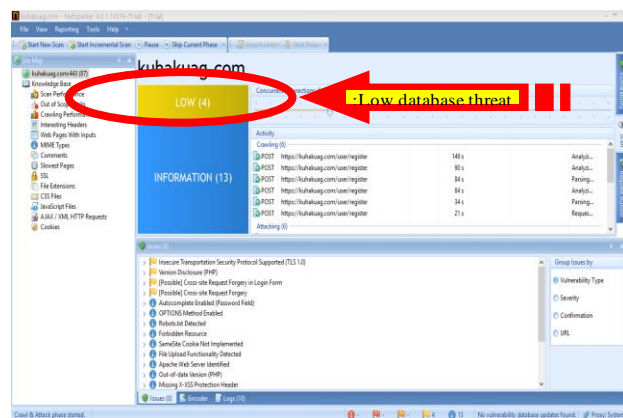


Fig. 5. Sample of SQL injection testing result

Finally, another way to examine the data security was by performing dynamic testing using SQL Injection (SQLI) technique. SQLI is considered as one of simple and most common web hacking techniques yet it could destroy the database. To run this testing, a sample of malicious SQL queries, String # and String 'OR'='1' against a database server was injected into username and password of login form respectively. SQLI test was also conducted using NetSparker, a web application security, and vulnerability scanner to identify flaws in the database. Results indicated that the threat levels were rated as low as seen in Fig 5.

V. CONCLUSION

The objective of this study is to present quality criteria and metrics derived from existing models for assessing CMS e-commerce as seen in Table 1. Using the proposed model, five CMS e-commerce (WP e-commerce, Woocommerce, Virtuemart, Prestashop and OpenCart) were chosen, deployed, customised, hosted in an online server as case studies of e-commerce and then tested against the quality criteria and metrics. The overall finding was that this study has been able to demonstrate the usefulness of the proposed model, in guiding the assessment of CMS e-commerce. Therefore, this study made an important contribution to the existing knowledge by offering a quality model form which other researchers could use, adapt or extend the model for assessing OSS and CMS e-commerce in particular.

Another important finding was that using the proposed model, this study was able to gain insights into the quality of each CMS e-commerce websites investigated in the case study. The comparative analysis on the results found that there was no CMS with absolute quality performance. Instead, each of which has its own strength, weakness and different features in term of its freedom of use, ease of deployment, performance and security. Therefore, the findings offer a practical recommendation for those who are seeking the appropriate CMS for building e-commerce application for their business. While acknowledging the contribution, this study does not claim the proposed quality model is complete. Rather, it offers an overarching framework from which researchers can infuse additional

criteria or matrices and test the new model in their future studies.

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Analysis of the Working Position of Sandal Operator Using RULA and REBA Approach

at Sisman Corporation (SISCO)

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Abstract— One of the determinant factors in work productivity is an employee. An employee who feels comfortable with his work activities can increase productivity. In implementing the comfort for the employees, it is necessary to pay attention to the work position or posture which is ergonomic. this is because an ergonomic working environment could minimize injury or work accidents occurring. Ergonomics is the study of the interaction between humans and other elements in a system. Ergonomics approach in analyzing work position uses the REBA (Rapid Entire Body Assessment) and RULA (Rapid Upper Limb Assessment) method. The objective of this research is to analyse of operators' working position when producing sandals using the RULA and REBA method at SISCO. Based on the results and analysis of the work position or posture of SISCO operators when carrying out production activities using REBA or RULA method approach, results indicated that either in the work position/posture A or standing, it has a high risk level with a score of 9 on REBA and 8 on RULA. It means that the work position is not recommended because of the high risk of injury, thus it needs an improvement from the operator's position or the workplace. In position B (squat) and C (sit) have a score of 5 on RULA and REBA which have a medium level. It means that it needs an improvement.

Keywords— Ergonomics; RULA; REBA; Work Position

I. INTRODUCTION

SISMAN CORPORATION (SISCO) is a company focusing on sandals production. The sandals produced by SISCO can be regarded as the unique one, because the customers can order sandals based on their preferences, including color, name and design. The production process that took place still uses a man-machine system, so that the operator has full control in carrying out its activities. In practice, the production activities carried out manually are still based on personal comfort without considering ergonomic aspects, because of the absence of standard work instructions for each work activity. Thus, the activities and work positions performed by employees or operators often result in complaints of waist pain and neck by employees or operators. It highly influence affects the operators' work productivity. The productivity is determined by several factors, including human resources, namely employees. Every employee is required to do the right things and work the things right, no matter where

they are placed [10]. One of the ways that can be conducted to increase productivity is through paying attention to the position or comfortable and ergonomic working posture for workers [3]. Measuring the operators' position is very important because the position at work greatly affects production activities. Ergonomic work position makes the operators focus more on their work and minimizes injury or work accidents [11].

Ergonomics is the study of the interaction between humans and other elements in a system [4]. Ergonomics approach in analyzing work positions, uses the RULA and REBA method. REBA (Rapid Entire Body Assessment) is a method developed in the field of ergonomics and can be used quickly to assess the work position or posture of the neck, back, arm and leg of operators [7]. The RULA (Rapid Upper Limb Assessment) method is a method a survey developed for ergonomic investigations about the workplace which is related to upper limb disorders [1][5]. Based on the background above, the focus of the observation in this study is to analyse of operators' working position when producing sandals using the RULA and REBA method at SISCO.

II. LITERATURE REVIEW

The utilization of human power in industry in Indonesia is still very dominant. One of them is the production activity with man machine system. This is because the operator has full control in carrying out its activities. In practice, the production activities carried out by employees are still based on personal comfort without considering the ergonomic aspects especially the operators' work posture itself, so that the work posture becomes an interesting matter to be studied further. One of working posture analysis methods is RULA and REBA.

A. Rapid Upper Limb Assessment (RULA)

This RULA method designed by [5] used to analyze body posture to investigate disorders of the upper limbs, by providing a calculation of the level of musculoskeletal load in a work that has a risk to the body part from the stomach to the neck or upper limbs. The input in this method is in the form of posture (palms, upper arms, forearms, back and neck), the load lifted, the energy used (static / dynamic), and the amount of work. Each movement activity is given a score that has been set on The RULA Scoring Sheet. RULA is developed as a

method to detect work posture as a cause of risk factors and is designed to assess employees and find out musculoskeletal loads that may cause disorders on the upper limbs.

RULA Employee Assessment Worksheet

A. Arm and Wrist Analysis

Step 1: Locate Upper Arm Position: 1 2 3 4

Step 2: Locate Lower Arm Position: 1 2 3 4

Step 3: Locate Wrist Position: 1 2 3 4

Step 4: Wrist Twist: 1 2 3 4

Step 5: Add Muscle Use Score: 1 2 3 4

Step 6: Add Force/Load Score: 1 2 3 4

Step 7: Find Row in Table C: 1 2 3 4

B. Neck, Trunk and Leg Analysis

Step 9: Locate Neck Position: 1 2 3 4

Step 10: Locate Trunk Position: 1 2 3 4

Step 11: Legs: 1 2 3 4

Step 12: Look-up Posture Score in Table B: 1 2 3 4

Step 13: Add Muscle Use Score: 1 2 3 4

Step 14: Add Force/Load Score: 1 2 3 4

Step 15: Find Column in Table C: 1 2 3 4

Table A: Wrist Posture Score

Upper Arm	Lower Arm	Wrist	Twist	Muscle Use	Force/Load
1	1	1	1	1	1
2	2	2	2	2	2
3	3	3	3	3	3
4	4	4	4	4	4

Table B: Neck, Trunk and Leg Scores

Neck	Trunk	Legs
1	1	1
2	2	2
3	3	3
4	4	4

Table C: Neck, Trunk and Leg Scores

Neck	Trunk	Legs
1	1	1
2	2	2
3	3	3
4	4	4

Scoring: (Final score from Table C)

1 or 2 = acceptable posture
3 or 4 = further investigation, change may be needed
5 or 6 = further investigation, change soon
7 = investigate and implement change

Final Score

Fig. 1. The RULA Scoring Sheet

The RULA method uses a diagram of body posture and three score tables in determining the evaluation of risk factors. The risk factors which have been investigated as external load factors consist of : Number of movements, static muscle work, power/strength, determination of work posture by equipment, working time without rest[5][1]. the RULA methods is a tool requires no special equipment in providing a quick assessment of the postures of the neck, trunk and upper limbs along with muscle function and the external loads experienced by the body A coding system is used to generate an action list which indicates the level of intervention required to reduce the risks of injury due to physical loading on the operator[5].

B. Rapid Entire Body Assessment (REBA)

REBA is a method used to analyze a work based on body position. This method is designed by [6] to evaluate work or activity, where it has a tendency to cause discomfort such as fatigue in the spine, arms, neck and so on. The REBA method evaluates work by giving a score based on 5 different level activities. The result indicates the level of risk faced by employees or operators in carrying out their work activities and the workload they bear. The risk of the work is related to muscle and posture disease.

In REBA analysis, there are two categories of body posture, namely category A and B. Category A consists of body, neck and legs, while category B consists of upper and lower arms and wrists for left and right movements. Each category has a complete body posture rating scale with additional notes that can be used as consideration for repair design. After assessing body posture, it scores the load or energy used and the factors associated with the coupling [6][7]. The score for each body posture is obtained from the REBA assessment table. The total score in category A is the score obtained from the total score of body posture contained in table A with the score of the load or power. The total score in category B is the score obtained from

the sum of the body posture scores found in table B with the coupling score for both hand. REBA score is obtained by looking at the score of category A and B in table C in order to obtain the score of C. Then it is added to the score of the activity. While the level of working risk is obtained from the REBA decision table[2][6][7]. REBA has been developed to "If a perceived need for a practitioner's "eld tool,specically designed to be sensitive to the type of unpredictable working postures found in health care and other service industries [7]

Rapid Entire Body Assessment (REBA) Assessment Worksheet

A. Neck

B. Upper Limbs

C. Lower Limbs

D. Neck, Trunk and Leg Scores

Table A: Neck Posture Score

Neck	Trunk	Legs
1	1	1
2	2	2
3	3	3
4	4	4

Table B: Upper Limbs Posture Score

Upper Limbs	Lower Limbs
1	1
2	2
3	3
4	4

Table C: Neck, Trunk and Leg Scores

Neck	Trunk	Legs
1	1	1
2	2	2
3	3	3
4	4	4

Scoring: (Final score from Table C)

1 or 2 = acceptable posture
3 or 4 = further investigation, change may be needed
5 or 6 = further investigation, change soon
7 = investigate and implement change

Final Score

Fig. 2. The REBA Scoring Sheet

III. RESEARCH APPROACH


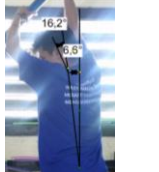


The method used in solving the problem of SISCO operators' work position or posture which has risk of injury is by modeling the problem using position or posture analysis with RULA and REBA analysis approach and visio software. The position / work posture using the REBA method approach is divided into three work positions namely work position A, work position B and work position C, while in the RULA method approach is divided into three work positions including standing work position, squat work position and sitting work position.

IV. RESULT AND ANALYSIS

A. Method of Work Position A

The work position A consists of three parts of the work position, namely the sponging work position, the name of the sponge and the plucking of the rest of sandals, because all of them are the same. Thus, it is enough to take REBA measurements in one of the work positions.

TABLE I. REBA METHOD OF WORK POSITION A


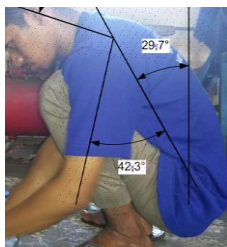
Step	Figure	Work Posture	Score	Information
1		Neck Position	+1	The angle of twisted neck is <20 °
2		Body Position	+2	The body is leaning forward but the angle is 6.6 ° or not more than 20 °
3		Legs Position	+1	The position of legs is straight or not bend
4		Upper Arm Score	+5	The operators' hand when punching is lifted up or more than 90 °. The score is +4. The operators' shoulder is lifted up and the score is +1
5		Lower Arm Position	+2	The operators' forearm is lifted up
6		Wrist Position	+1	The operators' wrist is straight

Based on the score in step 1-3, the score on the table A score is 2 is, while the score for the load is +2 that the load when carrying out the slurry of about 8 kg (17.673 pounds). With that condition, there is a shock during the sweep process, so total score A is 4. Likewise the score in steps 4-6, the score obtained in table B is +7, while the score for the handle or coupling is +0 because the handle of the operator is good, so the total score B is 7. The operators' activity is repeating and the activity causes a large or unstable change, so the additional activity score is +2, so the REBA final score uses Table C which is added with an additional score for the activity, where the previous step score A is 4, score B is 7 and score an additional 2. It is 9 and is the REBA score on posture / work position A.

B. REBA Method of Work Position B

The work position B consists of three parts, namely the working position of giving glue to the bottom of the sandal and gluing the base of the sandal with a sponge. Because all of them are the same, so it just take REBA measurements in one of the work positions.

TABLE II. REBA METHOD OF WORK POSITION B

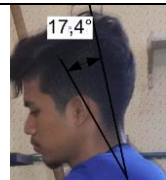
Step	Figure	Work Posture	Score	Information
1		Neck Position	+2	The angle of twisted neck is > 20 °
2		Body Position	+3	The body is leaning forward at an angle of 29.7 ° or more than 20 °
3		Legs Position	+2	The legs position bend
4		Upper Arm Score	+2	The operators' hand when gluing is at an angle of 42.3 ° measured from the operators' body and shoulders are stable or not lifted
5		Lower Arm Position	+1	The operators' forearm which is at an angle of 80 ° - 100 ° is 93.2 °
6		Wrist Position	+2	The operators' wrist tends to bend






Based on the score in steps 1-3, the score obtained in the table A score is +5 while the score for the load is +0 that when carrying out the gluing of <1 kg (<2.20462 pounds) with the condition of shaking during the punching process occurs, the total score A is 5. Likewise the score in steps 4-6, the score obtained in table B is +2, while the score for the handle or coupling is +0 because the handle of the operator is good, so the total score B is +2. Due to the existence of repeating operators' activity, the additional activity score is +1, so that the final REBA score uses Table C which is added with an additional score for the activity, where the previous score A is 5, the score B is 2 and the additional score is 1. It is 5 and is a REBA score on workposture or position B.

C. REBA Method of Work Position C

The work position C consists of two work positions, namely the working position of the sanding and the installation of sandals telli. Because both are the same, it just take REBA measurements in one of the work positions.

TABLE III. REBA METHOD OF WORK POSITION C

Step	Figure	Work Posture	Score	Information
1		Neck Position	+1	The angle of twisted neck is <20 °


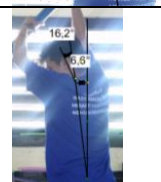

Step	Figure	Work Posture	Score	Information
2		Body Position	+2	The body is leaning forward at an angle of 12.5 ° or less than 20
3		Legs Position	+2	The legs position bend
4		Upper Arm Score	+2	The operators' hand when punching and being lifted at an angle of 52.3 measured from the operators' body and shoulders are stable or not lifted
5		Lower Arm Position	+2	The operators' forearm at an angle of > 100 ° is 106.4 °
6		Wrist Position	+2	The operators' wrist tends to bend

Based on the scores in steps 1-3, the score obtained in the table of score A is +2, while the score for the load obtained is +0 that when sanding about <5 kg or <11 pounds, the total score A is 2. Likewise the score in steps 4-6, the score in table B is +5, while the score for the handle or coupling is +0 because the handle of the operator is good, so the total score of B is +5. Due to the existence of repeating operators' activity, the additional score of the activity is +1, so the REBA final score uses Table C which is added with an additional score for the activity, where the previous score A is 2, the score B is 5 and the additional score is 1. It is 5 is and is a REBA score on the work posture/position C.

Analysis of REBA score aims to determine the level of injury risk for the operator and to determine whether the corrective action is needed from the operators' position or workplace in accordance with the score produced. Based on the data above categorized in the REBA level action, the work position A is the highest category among the others. It is 9, so that for corrective action it needs to be conducted immediately, otherwise the operator will experience fatigue faster and also the operator has a greater chance of experiencing injury risk.

D. RULA Method of Standing Work Position


TABLE IV. RULA METHOD OF STANDING WORK POSITION

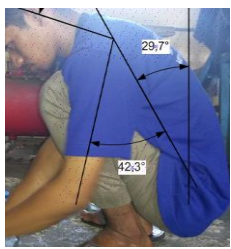

Step	Figure	Work Posture	Score	Information
1		Neck Position	+1	The angle of twisted neck is <20 °
2		Body Position	+2	The body is leaning forward but the angle is 6.6 ° or not more than 20 °
3		Upper Arm Score	+5	The operators' hand when punching is lifted up or more than 90 °. The score is +4. The operators' shoulder is lifted up and the score is +1
4		Lower Arm Position	+2	The operators' forearm is lifted up
5		Wrist Position	+1	The operators' wrist is straight

Based on the score in step 1-2, the score obtained in the table of score A is +2, while the score for the load gained is +2. The description of the load is when carrying out the slurry of about 8 kg (17.673 pounds), there is a shock in punching process, so the total score A is 4. As well as the score in step 3-5, the score in table B is +7. While the score for the handle or coupling is +0 because the handle is good, so the total score of B is +7. Through repeating operator activities, these activities cause large or unstable changes, so the additional activity score is +2. The final RULA score uses Table C which is added with additional scores for activities, where the previous step A score is +4, score B is +7 and additional score is +2. It is exactly 8 and is the RULA score on the standing work posture / position.

E. RULA Method of Squat Position

TABLE V. RULA METHOD OF SQUAT POSITION

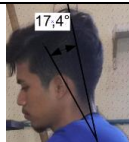


Step	Figure	Work Posture	Score	Information
1		Neck Position	+2	The angle of twisted neck is > 20 °
2		Body Position	+3	The body is leaning forward at an angle of 29.7 ° or more than 20 °


Step	Figure	Work Posture	Score	Information
3		Upper Arm Score	+2	The operators' hand when gluing is at an angle of 42.3° measured from the operators' body and shoulders are stable or not lifted
4		Lower Arm Position	+1	The operators' forearm which is at an angle of 80° - 100° is 93.2°
5		Wrist Position	+2	The operators' wrist tends to bend

Based on the score in step 1-2, the score obtained in table A score is +5, while the score for the load is +0 that when carrying out the gluing around <1 kg (<2.20462 pounds) with the condition of shaking during the punching process occurs, the total score A is 5. Likewise the score in step 3-5, the score obtained in table B is equal to +3, while the score for the handle or coupling is +0 because the handle of the operator is good, so the total score of B is +3. There is repeating operator activity, so that the additional activity score is +1 and the final score of RULA uses Table C which is added with an additional score for the activity, where the previous step A score is 5, score B is +3 and additional score is 1. It is 5 and is the RULA score on the squat posture / work position.

F. RULA Method of Sitting Position

TABLE VI. RULA METHOD OF SITTING POSITION

Step	Figure	Work Posture	Score	Information
1		Neck Position	+1	The angle of twisted neck is <20°
2		Body Position	+2	The body is leaning forward at an angle of 12.5° or less than 20
3		Upper Arm Score	+3	The operators' hand when punching and being lifted at an angle of 52.3° measured from the operators' body and shoulders are stable or not lifted

Step	Figure	Work Posture	Score	Information
4		Lower Arm Position	+2	The operators' forearm at an angle of > 100° is 106.4°
5		Wrist Position	+2	The operators' wrist tends to bend

Based on the score in step 1-2, the score obtained in the table of score A is +2, while the score for the load is +0 that when sanding about <5 kg or <11 pounds, the total score A is 2. Likewise the score in step 3-5, the score in table B is +5, while the score for the handle or clutch is +0 because the handle of the operator is good, so the total score B is +5. There is repeating operator activity, so that the additional activity score is +1 and the final score of RULA uses Table C which is added with an additional score for the activity, where the previous step A score is 2, the B score is 5 and the additional score is 1. It is 5 and is the RULA score on the sitting work posture / position.

RULA score analysis aims to determine the level of injury risk to the operators and to find out whether the corrective action is needed from the operators' position or workplace in accordance with the score produced. Based on the data above and categorized in the RULA action level, the work position A is the highest category among the others. It is equal to 8, so it needs to be conducted as soon as possible, otherwise the operator will experience fatigue faster and also the operator has a greater chance of experiencing injury risk.

V. CONCLUSION

The objective of this research is to analyse of operators' working position when producing sandals using the RULA and REBA method at SISCO. Based on the results and analysis of the work position or posture of SISCO operators when carrying out production activities using REBA or RULA method approach. Results indicated that either in the work position/posture A or standing, it has a high risk level with a score of 9 on REBA and 8 on RULA. It means that the work position is not recommended because of the high risk of injury, thus it needs an improvement from the operator's position or the workplace. The position of B and C has a moderate score level so it needs an improvement on the position or the work station is in the near future.

ACKNOWLEDGMENT

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Designing and Implementing Trajectory Planning and Inverse Kinematics Algorithms using Hexapod Robot Platform

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Abstract—Among various forms of developed robots, legged robots are often used to overcome problems that cannot be solved by wheeled robots. The often occurred problem while developing this typical robot is about the flexibility and efficiency of the robot movement. In addressing the problem, this research aimed to design and implement trajectory planning and inverse kinematics algorithms using hexapod robot platform with three degrees of freedom on each leg. The use of both algorithms' models was to make the legged robots move smoother and easier to manage so that the robots would move according to the desired inputs. This research used smartphones as a support control system. By having 13 testing times with different angles, a perfectly moving robot corresponding to an input angle was amounted 31%, 54% for a moving robot with an offset angle below five degrees, and 15% for a robot moving with an offset angle above five degrees.

Keywords—hexapod; inverse kinematics; trajectory planning

I. INTRODUCTION

Robotics technology currently confronts a very rapid development, which is very influential and useful in several fields such as medicine, education, industry, agriculture, health, household, and assistive devices. In education scope, robots are used as research and development materials to produce something better and useful. Among various forms of developed robots, one of which is a mobile robot that can be classified into two types namely wheeled and legged robots. Wheeled robots are those that are able to maneuver using wheels, either with two or more wheels. Meanwhile, legged robots are those that can maneuver with artificial legs, such as, robots with 2 feet called biped robots, three-legged (tripod), four-legged (tetrapod), and six-legged robots (hexapod) [1].

Most wheeled robots' movement hardly experiences problems in its settings except for the two-wheeled types. On the contrary, the regulatory problems often arise in legged robots regardless the numbers of their legs. Legged robots consist of servo motors controlled in an angle to achieve the desired position. Such desired position can be determined by using a trial-error method that scholars often call it as forward

kinematics. Unfortunately, such method remains inflexible and problematic. Therefore, this research aims to apply the inverse kinematics calculation method to automatically assign angle values to each servo motor and also to the trajectory planning system to make the robot's trajectory move more flexible. This research uses six legs or Hexapod robot with 3 degree of freedom (DOF) on each leg [2].

II. REVIEW OF LITERATURES

A. Hexapod Robot

Hexapod robot is a type of legged robots that moves using six feet or legs. This typical robot is statistically more stable because of the presence of the six legs compared to other types of the similar class. If one leg of the hexapod robot does not work well, the robot still can run. Moreover, not only for the sake of the robot stability, the other legs might help the robot move freely to find new footing to step and walk [3].

B. Inverse Kinematics

Inverse Kinematics is an analytical method for transforming Cartesian space to a joint space. In accordance to the kinematics equation, it can be obtained the relationship between the concepts of a joint space geometry in a robot with the concept of coordinates that are commonly used to determine the position of an object. With the kinematics model, the programmer can determine the input reference configuration fed to each actuator that enables the robot perform simultaneous movements to reach the desired position.

Inverse kinematics equation can be formulated by applying trigonometry by looking at each joint in one movement direction. Fig.1. shows the robot feet modeling in three dimensions mode (3D) [4][5].

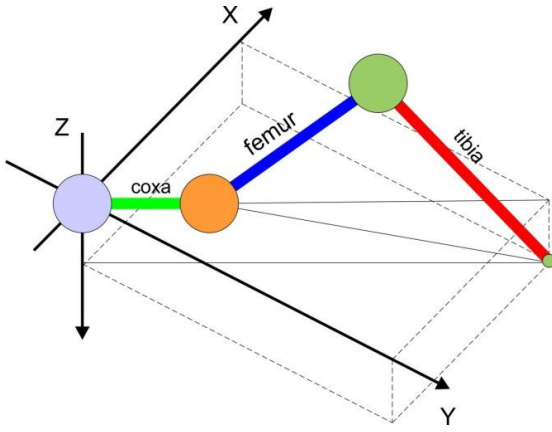


Fig. 1. Robot feet modelling in 3D mode

Simplifying by changing 3D to 2D modes is necessary to find the solution from the addressed inverse kinematics. To find the values of the joint parameter, it can be conducted by looking at the movement of the coxa link on the x and y axes in which the equation can be drawn as follows:

$$\alpha = \arctan\left(\frac{x}{y}\right) \quad (1)$$

In addition, Fig.2. shows the tangent function used in this research.

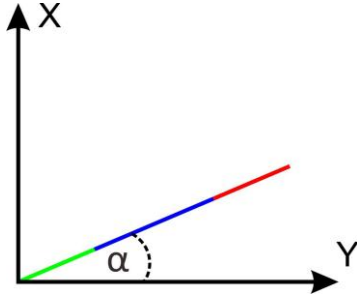


Fig. 2. Tangent function angles

The next vital parameter is the knee parameter value in which this parameter is important to make the femur move and to make the joint parameters move the tibia. Fig.3. portrays the 2-dimensional (2D) modeling of the robot legs [6].

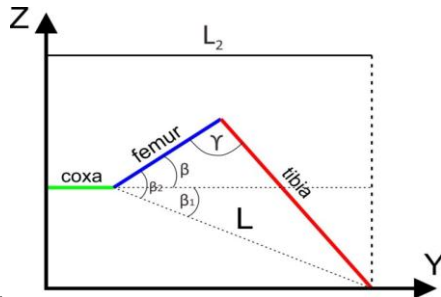


Fig. 3. Robot feet modelling in 2D mode

$$L_2 = \sqrt{x^2 + y^2} \quad (2)$$

$$\beta_1 = \arctan\left(\frac{z}{L_2 - coxa}\right) \quad (3)$$

$$L = \sqrt{(L_2 - coxa)^2 + z^2} \quad (4)$$

By considering cosine rules, β and γ values can be obtained through the following equations:

$$\cos \beta_2 = \frac{L^2 + femur^2 - tibia^2}{2.L.femur} \quad (5)$$

$$\beta_2 = \arccos\left(\frac{L^2 + femur^2 - tibia^2}{2.L.femur}\right) \quad (6)$$

$$\beta = \beta_2 - \beta_1 \quad (7)$$

$$\cos \gamma = \frac{tibia^2 + femur^2 - L^2}{2.femur.tibia} \quad (8)$$

$$\gamma = \arccos\left(\frac{tibia^2 + femur^2 - L^2}{2.femur.tibia}\right) \quad (9)$$

In programming languages, there are several things to note covering:

- The arc cos (acos) function does not have good accuracy in recovering cos values because $\cos(\theta) = \cos(-\theta)$.
- When $\sin(\theta)$ is close to zero, i.e. $\theta \approx 0^\circ$ or $\theta \approx 180^\circ$, a calculation error will be inaccurate and even not defined. In computer programming, such phenomena can cause the calculation to be NaN or indefinable. To prevent the occurrence of such calculation errors in programming, the calculation manipulation with the function used in the programming language should refer to $\text{atan2}(y, x)$ by looking at the quadrant of the AT2 function (arctan2).

$$\theta = \arctan 2(y, x) = \begin{cases} 0^\circ \leq \theta \leq 90^\circ, \text{ for } +x \text{ and } +y \\ 90^\circ \leq \theta \leq 180^\circ, \text{ for } -x \text{ and } +y \\ -180^\circ \leq \theta \leq -90^\circ, \text{ for } -x \text{ and } -y \\ -90^\circ \leq \theta \leq 0^\circ, \text{ for } +x \text{ and } -y \end{cases}$$

Couples of important notes regarding $\text{atan2}(y, x)$ function include:

- The atan function recovers the value between $\pi/2$ and $-\pi/2$
- The atan2 function recovers the value between π and $-\pi$ using x and y with numbers signed + or -.

$$c) \tan \theta^\circ = \frac{\sin \theta^\circ}{\cos \theta^\circ}$$

Henceforth, the equation 5 can be changed into atan2 using a mathematical analogy of $\cos \beta_2 = A$ and $\sin \beta_2 = \pm\sqrt{1-A}$, so:

$$\beta_2 = \arctan 2 \left(\frac{\sqrt{1-A^2}}{A} \right) \quad (10)$$

And, the equation 8 also can be changed using an analogy $\cos \gamma = D$ and $\sin \gamma = \pm\sqrt{1-D^2}$, so:

$$\gamma = \arctan 2 \left(\frac{\sqrt{1-D^2}}{D} \right) \quad (11)$$

C. Trajectory Planning

Trajectory planning is a planning path or track used as a reference step on Hexapod robot. This trajectory planning uses the basic trigonometric concepts where the sin and cos functions are needed. Fig.4. shows a parabolic trajectory to make the feet able to move.



Fig. 4. Parabolic trajectory

However, this study only made four different trajectories that would be combined to finally create a parabolic trajectory in which the starting point lays on the middle (see Fig.5.). This is intended to no longer give transition effects on the robot when changing directions. So, the robot's initial and final positions will always be in the middle [7].

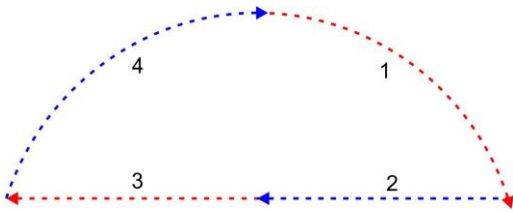


Fig. 5. Combined trajectories

To achieve the combined trajectories, the following equation must be encountered:

$$f_x = x \sin \left(\frac{t \times 90^\circ}{s} \right) \quad (12)$$

$$f_y = y \sin \left(\frac{t \times 90^\circ}{s} \right) \quad (13)$$

$$f_z = z - z \left(1 - \sin \left(\frac{(s-t) \times 90^\circ}{s} \right) \right) \quad (14)$$

x, y, and z are the displacement lengths for each axis. Whereas, t is the change in the displacement time and s is the amount of time changes for displacement. The greater the value of the time changes, the longer it will move.

The z value of tracks 2 and 3 is made to 0 so that the trajectory can be straight. Meanwhile, the t parameter will both increase and decrease in every track change and will be negative on tracks 3 and 4.

In this research, the robot runs using the three wave gait method, a walking method using 3 legs tread on the field and the other three legs lifting. When the legs tread on the field, the z values of tracks 1 and 4 are made into 0 while tracks 2 and 3 remain valuable according to the given input. Fig.6. helps visualize the track [8].

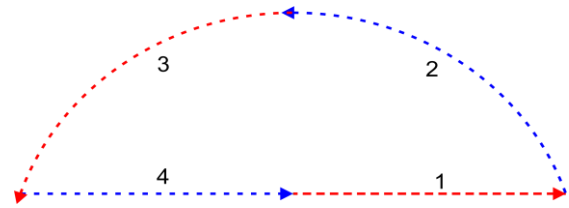


Fig. 6. Feet tracks when treading the ground

III. RESULTS AND DISCUSSION

Several tests were carried out from the system that was made previously in three stages namely inverse kinematics test, trajectory planning test, and maneuvering test.

A. Inverse Kinematics Test

Inverse kinematics test was done by taking one-foot sample, then giving the input value to the robot in a form of end effector coordinates which further produced servo angles in accordance with the given input. The results of these angles were later confirmed by manual mathematical calculations.

In this experiment, coxa = 3 arm values, femur arm = 4.5, and tibia arm = 6.2. Whereas, the input coordinates were entered randomly but not exceeding the total length of the arm in each coordinate. Table 1 shows the results obtained from the experiment.

TABLE I. RESULTS OF INVERSE KINEMATICS TEST

Input Coordinates			Calculation Results			Test Results		
x	y	z	θ_1	θ_2	θ_3	θ_1	θ_2	θ_3
0	13.7	0	0	0	180	0	0	180
0	12	-1	0	44.81	114.69	0	45	114
0	11	2	0	33.81	99.6	0	34	99

Input Coordinates			Calculation Results			Test Results		
x	y	z	θ_1	θ_2	θ_3	θ_1	θ_2	θ_3
0	10	3	0	31.29	89.29	0	33	89
0	9	4	0	24.91	83.11	0	26	82
-5	7	2	-35.54	51.62	65.31	-36	52	65
-8	5	3	-57.99	34.99	81.45	-58	35	81
-6	6	4	-45	26.73	76.95	-45	27	77
-5	4	9	-51.34	-38.5	127.4	-52	-39	127
-8	5	7	-57.99	-14.96	124.63	-58	-15	125

The calculation value in Table I was obtained from the inverse kinematics calculation that had been explained previously. θ_1 value represented servo 1, θ_2 value represented servo2, and θ_3 value represented servo 3. The following was one proof of the calculation conducted to get the results shown in Table I. In this case the researchers took the 6th experiment sample namely $x = -5$, $y = 7$, and $z = 2$.

Further proof could be continued by referring to the results shown in Table II.

TABLE II. ERROR VALUES FOR EACH EXPERIMENT TIME

Input Coordinates			Errors		
x	y	z	θ_1	θ_2	θ_3
0	13.7	0	0	0	0
0	12	-1	0	0.19	0.69
0	11	2	0	0.19	0.6
0	10	3	0	1.71	0.29
0	9	4	0	1.09	1.11
-5	7	2	0.46	0.38	0.31
-8	5	3	0.01	0.01	0.45
-6	6	4	0	0.27	0.05
-5	4	9	0.66	0.5	0.4
-8	5	7	0.01	0.04	0.37
Total Errors			1.14	4.38	4.27
Average Errors			0.114	0.438	0.427
Average of the Total Errors			0.326		

In accordance with Table 1, the average error or offset of each servo angle was obtained from the difference between the calculation result and the test results (see Table 2).

From the test results of inverse kinematics, it could be seen that the error or offset was quite small, which was about 0.326 degrees. This result was good because it did not make too much changes to the servo angle.

B. Trajectory Planning Test

TABLE III. RESULTS OF TRAJECTORY PLANNING TEST

t	fx	fy	fz
0	0	0	2
1	0.618034	0	1.902113
2	1.175571	0	1.618034
3	1.618034	0	1.175571
4	1.902113	0	0.618034
5	2	0	0
4	1.902113	0	0
3	1.618034	0	0
2	1.175571	0	0
1	0.618034	0	0

t	fx	fy	fz
0	0	0	0
-1	-0.618034	0	0
-2	-1.175571	0	0
-3	-1.618034	0	0
-4	-1.902113	0	0
-5	-2	0	0
-4	-1.902113	0	0.618034
-3	-1.618034	0	1.175571
-2	-1.175571	0	1.618034
-1	-0.618034	0	1.902113
0	0	0	2

Trajectory planning test was also conducted by taking one foot sample. The robot foot was given a desired input in a form of the amount of time changes and the displacement lengths for each axis coordinate. Thus, the robot's legs could move according to the determined trajectory planning path or track.

In this test, the s value was 5 (the amount of displacement time), x length = 2, y length = 0, and z length = 2. In accordance with the trajectory planning formula described earlier, to make a parabolic trajectory, the merger between the trajectories was carried out and the results were shown in Table 3.

From the results depicted in Table III, it was then implemented on the robot's foot. In this case, programming each path using the "for" function was necessary and the robot foot would make a parabolic trajectory pattern like the graph shown in Fig. 7.

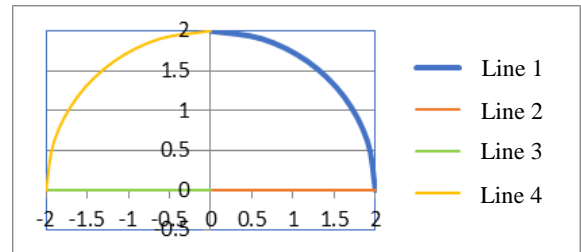


Fig. 7. Graphic results of trajectory planning test

C. Maneuver Test

In this test, the robot used a walking method with three wave gait. The three-wave gait method was a walking method using three feet to tread on the field while other three legs to move. The purpose of this test was to determine the efficiency and effectiveness of the running method of the three wave-gait combined with the use of inverse kinematics.

To get the x and y values, the researchers only needed to enter the length input values or the length of the steps and the desired angle of motion of the robot using the following formula.

$$x = \text{length} \times \cos \theta$$

$$y = \text{length} \times \sin \theta$$

During the test, the robot received data from the smartphone via Bluetooth and it would move according to the data received. The data received by the robot was in the form of rotation angle for maneuvering and determining range of steps and speed. The GUI interface on the smartphone could be seen in Fig.8.

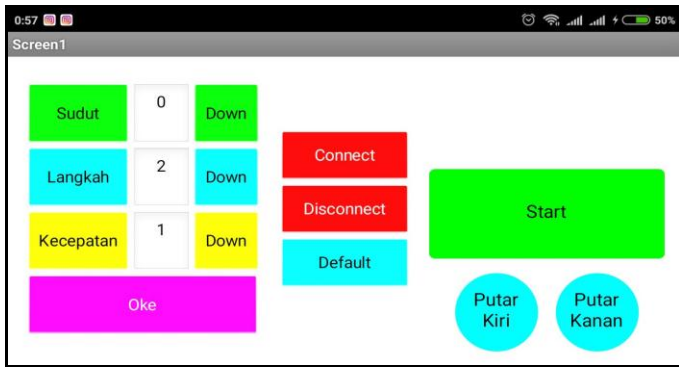


Fig. 8. GUI interface on smartphones

By sending data from a smartphone, the robot was able to pass the predetermined test track. Fig.9. shows the test track used in this test.

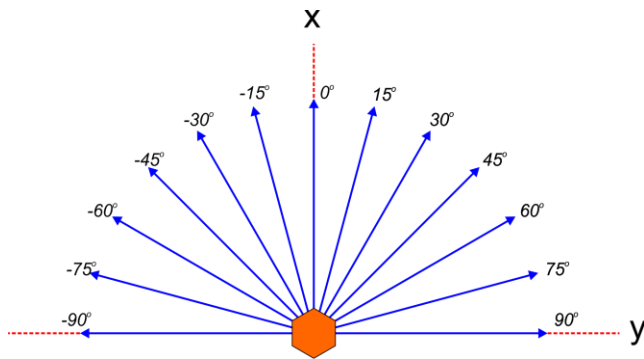


Fig. 9. Tracks in maneuvering test

TABLE IV. RESULTS OF MANEUVERING TEST

Determined Angle	Test Results	Offset
0	-1	1
15	22	7
30	31	1
45	43	2
60	62	2
75	75	0
90	90	0
-15	-13	2
-30	-30	0
-45	-41	4
-60	-66	6
-75	-75	0
-90	-92	2

For the 13 experiments with different angles, it could be seen that the robot moved perfectly through the trajectory four

times (31%), traversed the trajectory at an offset below five degrees seven times (54%), and crossed the trajectory offset above five degrees twice (15%)

Based on the results found at the above tests, the movement of the robot was still not completely perfect caused by several factors including servo motors that had worn out and lacked of mechanical design and calibration of the inverse kinematics and trajectory planning on the robot.

IV. CONCLUSION

By referring to the test results and the implementation, this research concludes that the result between the undertaken inverse kinematics calculation and the real implementation shows error amounting 0.326. Meaning that, the result is good because the error level does not make a significant change in the servo angle. Moreover, the robot can actually move according to the desired trajectory using a trajectory planning, so that the movement of the robot is more effective. At last, this research identifies that, with the three wave gait walking method combined with the inverse kinematics and trajectory planning methods, the robot moves perfectly across the trajectory by 31%, crosses the trajectory with an offset below 5 degrees by 54%, and crosses the trajectory with an offset above 5 degrees by 15 %, in which the test is conducted for 13 times with different angles.

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Developing A-Freemium Mobile Games Software Based On Augmented Reality-Commerce

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Abstract—Marketing methods for selling software have experienced many changes. In-app Purchase Method (IAP) is one of the breakthrough solutions in selling a freemium software, where users can download and use the application for free, but there are premium features that must be paid. One of the challenges on the IAP system in mobile games is when choosing the type of payment media to buy a premium feature: several interruptions on internet connection and different server error may also reduce user satisfaction. This study aims to provide a solution by applying an Augmented Reality (AR) technology to the IAP system, so the system no longer requires an internet connection to the game server and the users easier to make the expenditure. The system is applied on the purchasing system in the Heroes of Surabaya mobile games which run on android operating system. Through AR technology, the purchasing system done by recognizing the markers. Thus, we contribute to provide an alternative solution for premium-app purchasing system, which normally it must be paid using digital money that not everyone recognizes and has it. So, the only need to do for every user who wants to buy premium feature/items in our mobile games is buying a marker card. From the experimental results, our application gets 96% user satisfaction from attractive sales innovations, but the speed only gets 35% of the level of user satisfaction. Light and distance markers are a key factor in the success rate in marker detection.

Keywords— *Augmented Reality, In-App Purchase, Freemium, Mobile Game*

I. INTRODUCTION

In-App purchase (IAP) system is believed to be more effective in attracting consumers than the existing payments method. When an application developer utilizes the method in the sale of an application, there is a possibility that the developer will earn more and more frequently from one user. Unlike paid applications where application developers usually get one-time revenue from one user for each application, they have sold. Along with the rapid development of mobile application technology, a variety of applications emerged in various ways to market them. Likewise, in mobile game applications. Mobile game application developers use a variety of ways to monetize their applications, such as In-App Advertising, Freemium, Paid Apps, IAP, Paywalls, and Sponsorship [1]–[3]. Several studies of user purchase behavior

trends indicate that users prefer IAP and Freemium compared to payments in the beginning [4]–[7].

Our research aim to investigate an application of AR technology to an IAP system to improve user experience and provide alternative payment media solutions of the IAP system. Based on several studies shows that AR has a better market share compared to virtual reality. AR-app for commercial fields which called aCommerce is the second most popular in AR-app [8]–[10]. We are inspired by aCommerce from IKEA which utilizes AR technology in their sales catalog. The application is displaying the pictures of furniture to be purchased. Furthermore, users can immediately order the desired furniture by automatically connected to the IKEA web-commerce system, so that customers do not need to open the IKEA website or even visit the IKEA outlet to see the furniture model and place an order manually. [3].

We made the implementation of AR for IAP system based on paper-markers. It is for purchasing premium items and will be more suitable for being applied in mobile games as an innovative and attractive method. Furthermore, we have organized this article into a section for material, method, experiment result, analysis, and conclusion.

A. Mobile Games

Mobile games are video games that are built on mobile devices such as smartphones and tablet computers. While game consoles such as PlayStation or Nintendo are not considered mobile games. In its development, the emergence of smartphones and the availability of cellular internet changed the state of mobile games. The existence of a touch screen, high-quality graphics display, and the availability of connections to the network, offers a new experience for users. Moreover, users can download many applications and game variations from online application stores [2].

B. In-App Purchase

In-App Purchase (IAP) refers to a selling digital products from a mobile application, in the form of goods and services to users of the app [2]. This is another way to get profitability from software that can be sold at a low price or even free. IAP first introduced by Apple on the iOS platform. Currently, IAP is very popular among application developers, because they

can develop their applications with the freemium model, where users can download their free apps, but users are provided with

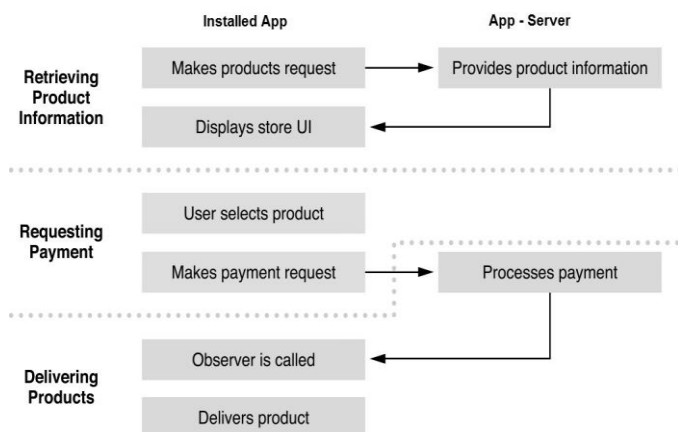


Fig. 1. Default InApp purchase system [4]

Premium features and content that can be purchased by users [4]. In the IAP system there are two payment models, i.e. standard (once paid) and subscription (pay for a certain period) [3]. Fig 1, shows the IAP system that already used in existing software-App. App with IAP usually very much need a stable internet connection to ensure transactions are not interrupted. The types of In-App Purchases products that we design refer to the recommendations proposed by APPLE as shown in Table 1 [5].

TABLE I. IN-APP PURCHASE PRODUCTS DESIGN [5]

Type of In-App Purchase	Content	Description
Consumables	Hp Extra Experience Extra Coin extra	Consumables are disposable items that require players to buy when they need it.
Nonconsumables	Level -Up Extra-Challenge	Nonconsumables are items that only need to be purchased once, and can be used many times.

C. Augmented Reality (AR)

AR is a technology that allows the immersion of virtual world into the real world. This technology has interactive and real-time properties. Through the identification of markers, 3D objects will appear in the real world [11]. Augmented Reality as a system that has the following characteristics:

- Combine real and virtual environments.
- Interactive ability with virtual objects in real time.
- Blending of three-dimensional objects into the real world.

Unlike Virtual Reality which makes the real world of users completely replaced by the virtual world, Augmented Reality is simply adding or completing a real environment by adding virtual objects in it. We used Vuforia AR software development kit (SDK) which available in <https://developer.vuforia.com/downloads/sdk>. Vuforia uses Computer Vision technology to recognize and track the

markers (images target) and simple 3D objects at the real-time. There are several benefits by using the VUFORIA SDK, i.e. fast target detection, and robust system even in low light.

II. MATERIAL AND METHOD

This section discusses the concept material developed by the application that has been designed and the details of the methods used in designing the application. We have successfully created "Heroes of Surabaya" (HOS) mobile games. This mobile game takes the theme of the war events on Jembatan Merah 10 November 1945 in the City of Surabaya.

It is necessary to have a research methodology that contains the steps needed to build the application. Fig.2 is our research methodology flowchart when building aCommerce on the mobile game HOS.

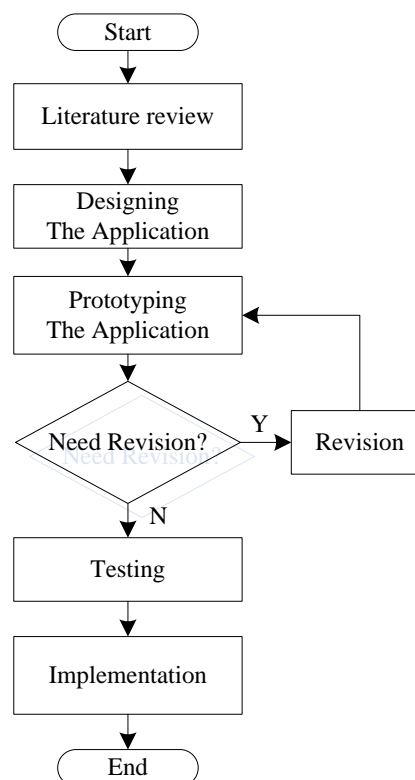


Fig. 2. Research flowchart

Fig. 3 describes the design flow of purchasing items in the shop menu. Purchases can be made by using coins; player will get the coin as a bonus when playing a game. Another payment method is using the AR method which requires the players to buy a marker card with real money.

When a player chooses to purchase an item using the coin-based method as the payment method, the coin player is subtracted according to the item price. All data is updated to the database of weapons and items; it will then display in real time. However, if the player chooses to purchase items by using AR as payment, the player will be directed to the ARshop menu. Fig. 4. show the ARshop menu flowchart.

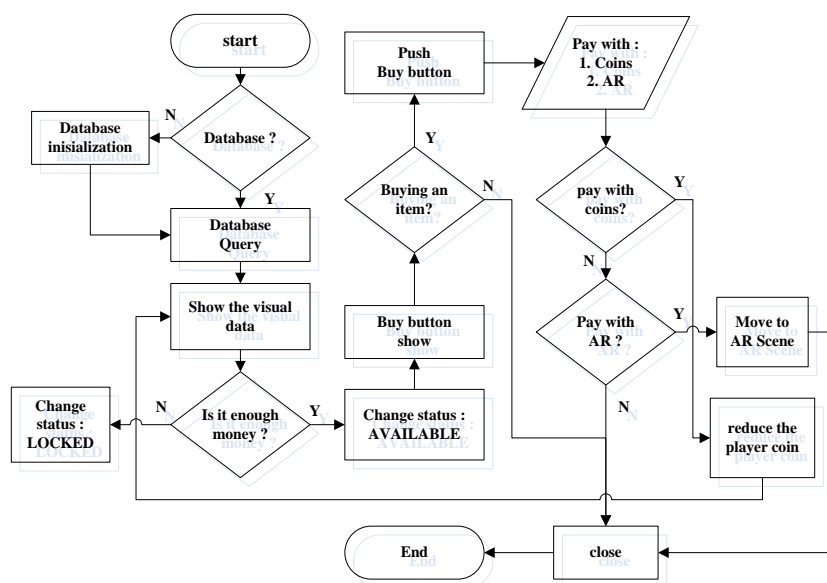


Fig. 3. The proposed system in AR purchasing system

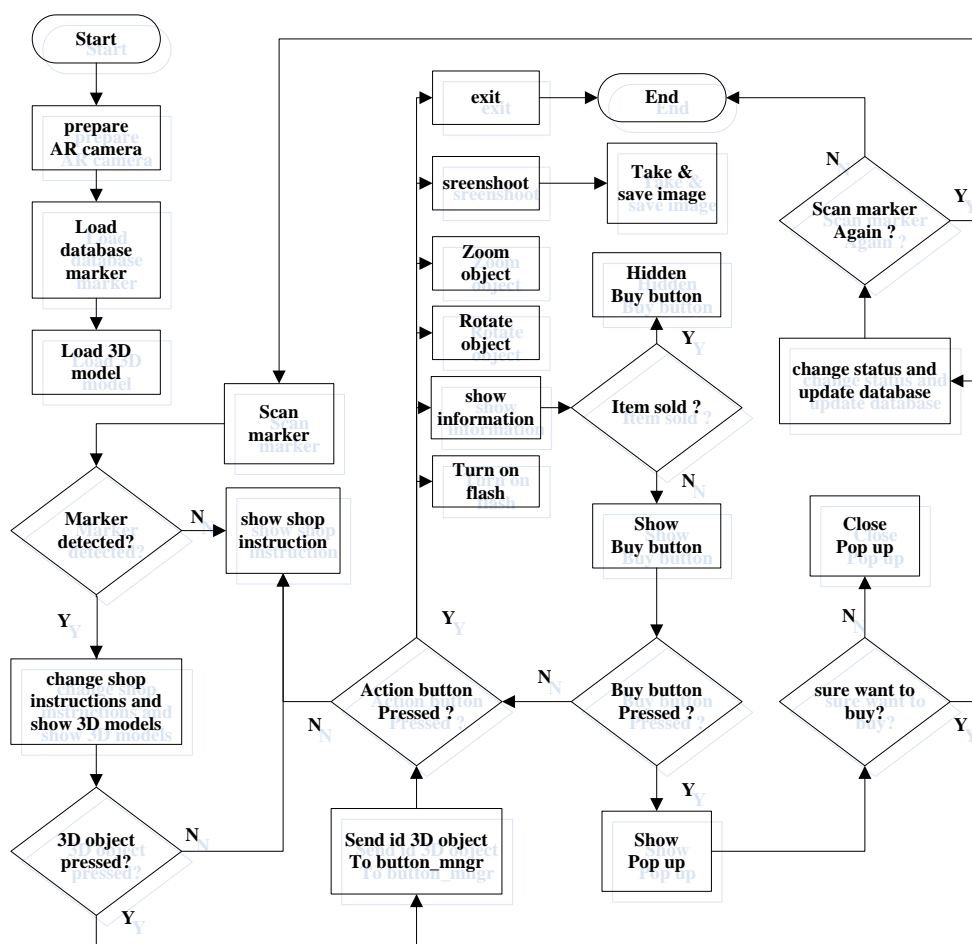


Fig. 4. ARshop menu flowchart

ARshop will then handle user transactions when the payment option is using AR-markers. Players will be able to interact and purchase the items according to markers which associated with specific 3D objects.

The Marker which used in our Augmented Reality Shop is a full-color marker (not only in black and white, but designed as a card which may later be a player collection. Design of the marker images are matched, regarded to the 3D objects that will be displayed so that players do not need to memorize the contents of each marker when they want to purchase items. Markers are also explained the content in it so that it can be more informative and useful. The sample of the marker is shown in Fig 5.



Fig. 5. A sample of markers design

III. EXPERIMENT RESULT AND ANALYSIS

A. IAP AR Implementation

The application of the IAP system using AR was carried out in the Heroes of Surabaya game, which tells the story of the struggle for Indonesia's independence in Surabaya. This 2-dimensional (2D) Real Time Strategy (RTS) game provides a variety of weapon items that can be purchased using a coin or AR marker cards.

When a player chooses to do purchase items using the coin as payment media, the coin player is reduced according to the price of the item purchased and all data later updated to the weapon database and items for then displayed live in real-time. But if the player chooses to buy items using AR as payment, then the player will be directed to the scene ARshop.

ARshop will handle transactions using marker as a medium for generating 3D objects. Players can interact and do purchase items according to the marker. ARshop able to provide solutions for payment media at in the IAP system by using marker as the payment medium. Examples of AR marker target images in a match the weapons and items in the game, appear in Fig. 6.

The marker is uploaded to the VUFORIA Developer website <https://developer.VUFORIA.com/targetmanager> and entered in one database. The file has been uploaded and then assessed for quality by the system from Fuvoria as in Fig. 7.



Fig. 6. Weapon Marker.



Fig. 7. Marker Rating

Fig. 7. shows that the uploaded marker was got five stars from Vuforia. The more stars, the better the detection process. The marker has been uploaded and then downloaded in format .unitypackage so that it can be read and exported to UNITY software. The uploader must be downloaded back to be included in the AR project. Markers can be downloaded on the same site when uploading it, and select UNITY editor as an option on the select platform.



Fig. 8. AR shop interface

Fig. 8. show the ARShop display which designed to make user easier to choose the command they want. The button only

located on the right, lined vertically. The button next to the top right corner is the exit button which used to exit ARShop goes back to the shop page. Screenshot button is used to capture the screen that the user wants. The zoom in button is useful for enlarging 3D objects desired, and the zoom out button to shrink 3D object. Below, it is the information button which containing information item, and also bring up the buy button if previously the item has not been purchased, so the user can directly buy the item inside this page. The rotation button used to rotate objects, so players can see various blades of 3D objects they want to buy. And the lower right corner button is the button flashlight which is useful for turning on flashlights to help marker capture when the marker scan is done in dim light conditions.

B. Hardware implementation

We do hardware implementation test to ensure the system and all the features are running as we planned. The prototype of the software is tested using different devices with different specifications. Three different smartphones are used in this stage. The purpose of this step is to find errors in the application. The test results can be seen in Table II. The results of the tests that have been carried out concluded that the game "Heroes of Surabaya" with aCommerce features runs well in various testing devices. All the functional analysis of the application features are showing that all the features of the application run well in all devices.

TABLE II. TRIAL ON VARIOUS DEVICES

Device	Specification	Result
Andromax C	OS. V4.1. CPU Dual-Core 1 GHz. RAM 512MB. 2 MP.	Good
Sony Xperia E3 Dual	OS. V4.4.2. CPU Quad-Core 1.2 GHz. RAM 1 GB. 5 MP + Flash	Good
Galaxy E5	OS. V.4.4.4 CPU Quad-Core 1.2 GHz. RAM 1.5 GB 5 MP + Flash	Good

C. User Experience Measurement

Testing the application functionality at this alpha stage is done using questionnaires involving 30 respondents. Testing utilizing this questionnaire gives ten questions, which are classified based on application functionality, user experience testing, and testing based on application benefits.

TABLE III. USER RESPONDS MEASUREMENT

Category									
Functionality			User experience				IAP		
Questionnaire Result (%)									
1	2	3	4	5	6	7	8	9	10
35	64	82	78	96	76	51	85	77	74

Table III shows the test results are based on the application functionality, the speed of running the application gets the

lowest value of the level of user satisfaction according to the application functionality category which is 35%, and the ability of the application to run according to its function get the value the highest is 82%. Whereas regarding user experience, the design of markers was ranked lowest of the level user satisfaction according to the user experience category that is equal to 51%, and Augmented Reality that attracts users to purchase items in the game get the highest score of 96%. On the side of the benefits of the application, the willingness of the user to use the app gets the lowest value from the level of user satisfaction according to the utility benefit category which is 74%, while providing application benefits to users as payment innovations from the In-app purchase system gets the highest score of 77%.

IV. CONCLUSION AND FURTHER RESEARCH

The novelty in this study is the creation of the Heroes of Surabaya mobile game which tells the history of the Surabaya people's struggle for independence and the implementation of AR technology to the IAP system. This study contribute to provide an alternative solution for premium-app purchasing system, which normally it must be paid using digital money.

From the results of the survey of the majority of users interested in AR commerce as alternative payments in IAP with a satisfaction level of 96%, but users feel the application is too slow to get a level satisfaction of 35% of users. This study succeeded in applying the AR trade as an IAP purchase, but there was a need to improve the quality of the game Heroes of Surabaya, to improve the perception purchased.

The advantage of this application is the ease of purchasing an item, no need for an internet connection, only requires AR markers. The drawback is the low speed of the purchase process, due to the influence of light received by AR markers. For further research, it is necessary to study on security procedures and accuracy of the use of AR markers, in order to prevent fraud in the purchasing process.

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Comparison of the Traveling Salesman Problem Analysis Using Neural Network Method

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Abstract—Traveling sales problem (TSP) is one of the classical optimization problems and NP-complete. The Challenge in implementing TSP is how to determine the shortest distance from a traveling route of N cities where each N city visited precisely once at time. In this paper, we attempt to analyze the completion of TSP using an artificial neural network approach. In network, weights are determined to represent problem boundaries and optimize the completion function. The approach of artificial neural networks used is a network with Hopfield algorithm and Simulated Annealing algorithm. The solution with the Hopfield algorithm has the complexity of the $4n^4 + 16n^3$ algorithm, while the complexity of the Simulated Annealing algorithm is $10n^2$. Judging from the use of memory in the implementation, the application of annealing algorithm is better than the Hopfield algorithm. but both are algorithms that "no works in place".

Keywords—traveling salesman problem; optimization; hopfield; neural networks

I. INTRODUCTION

Traveling Salesman Problem (TSP) is a complete NP problem [1] and NP-hard problem [2] which is up to now only a few individual cases found could be executed polynomial with a reducible Turing machine. TSP is a typical combinatorial optimization problem [3],[4],[5], which is simple to state but very difficult to solve. The problem in TSP is the difficulty in determining the journey path that will be taken. The very concerned determination of the journey path is the total distance of the trip, which is to find the shortest possible flow of travel through a set of N cities, each of which is visited exactly once, while there is an $N!/2N$ possible flow of travel. The greater the value of N, the bigger the likelihood of the trip path, thus it takes long time to design the desired trip plan. It happens because traveling salesmen have to look for possible ways to be traversed and decide the shortest path among all possible paths.

There have been many exact and heuristics algorithms designed a good solution. However, they vary regarding to

complexity and efficiency in resolving TSPs at various levels of complexity and size (small, medium and large). Previous research used linear programming of Dantzig et al.[6], effective formulations of Held and Karp [7], but their ability was limited to small problems (less than 40 cities). Later, the artificial intelligence approach has been proven to have the ability to solve more complex issues; one of those approaches is organized neural networks [8], [9], and then expanded as metaheuristic. A metaheuristic can optimize complex problems [10]. The way metaheuristic is done in solving problems is to search through many candidate solutions with little or no assumptions about the problem being solved and without any guarantee to find the optimal solution.

Recently there have been many optimization problems that can be solved using artificial neural networks [11]. An artificial neural networks approach, can solve TSP problems quickly [12]. Therefore, in this paper, the completion of TSP will show and compare two artificial neural network algorithms, namely the Hopfield algorithm and the Simulated Annealing algorithm.

II. METHOD

A. Traveling Salesman Problem

The definition of the traveling salesman problem is given n city and d_{ij} which is the distance between c_i cities and c_j cities. A salesman wants to make a closed track by visiting each city only once and the journey begins and ends in the same city[13], [14], [15], [16]. TSP has a problem limitation in two conditions, namely weak limitation and strong limitation [17].

Weak problem limitation. In this condition, the completion obtained will not be wrong even though the limitation of this problem is not fulfilled. Still, the limitation of the problem must be fulfilled whenever possible. The example is a path with minimum mileage.

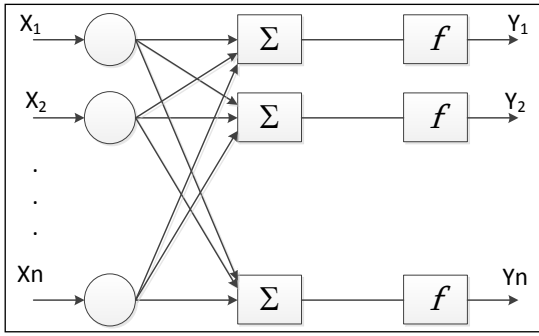


Fig. 1. Model of Single Layer Neural Network

Strong problem limitation. The limitation of problems must be fulfilled, otherwise the completion obtained will be wrong. The example is that every city listed in the itinerary must be visited once, not twice or more at the same time, and the journey begins and ends in the same city.

B. Artificial Neural Network

The artificial neural network is an information processing system that has specific characteristics similar to those in biological neural networks [18]. Artificial neural networks are designed as interconnection systems using elements of process called weights, each of which has many inputs and produces output.

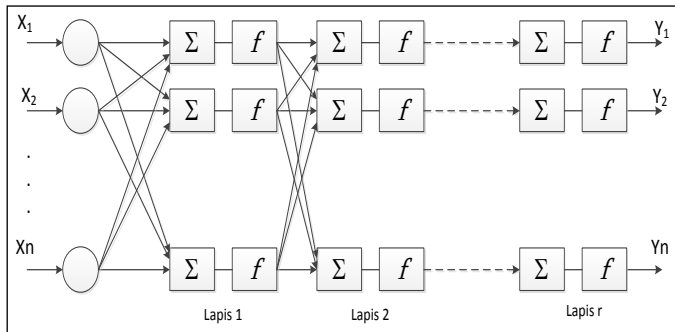


Fig. 2. Model of Multiple Layer Neural Networks

Seen from the number of layers, artificial neural networks are divided into two types, namely single layer neural network and multilayer neural network. The simplest network consists of a group of neurons arranged in one layer. The nodes on the left side of Figure 1 function only to distribute inputs and not to do calculations. Each of the X input elements is connected to each artificial neuron through a different weight.

Multiple layer neural networks have much better capabilities than single layer neural networks do. Simply put, multiple layer artificial neural networks can be made by arranging a set of single layer as shown in Fig 2.

C. Hopfield Neural Network

One of the artificial neural network architectures is the Hopfield Network. The Hopfield network consists of a number of nodes that are connected to each other[19],[20]. The

connections between units have a w_{ij} weight. The value of the weight is fixed and symmetrical, meaning that the weight between neuron i to neuron j is defined as w_{ij} , equal to the weight between the neurons j and neurons i defined as w_{ji} . The mathematic function is as follows:

$$\omega_{i\varphi} = \omega_{\varphi i} \quad (1)$$

The steps to solve the traveling salesman problem using the Hopfield algorithm network are as follows

Step 0: Initialize the activities of all units.

Initialize Δt with a small value, $\Delta t = 10^{-5}$

Step 1: If the STOP condition is wrong, do steps 2 - 6

Step 2: Do step 3 - 5 times n^2 times (n number of cities)

Step 3: Select a unit randomly

Step 4: Changes activation to select units:

$$u_{x,i}(\text{new}) = u_{x,i}(\text{old}) + \Delta t \left[-u_{x,i}(\text{old}) - A \sum_{j \neq i} v_{x,j} - B \sum_{y \neq x} v_{y,i} + C \{N - \sum_x \sum_j v_{x,j}\} - D \sum_{y \neq x} d_{x,y} (v_{y,i+1} + v_{y,i-1}) \right] \quad (2)$$

Step 5 : Use the output function:

$$v_{x,i} = 0.5[1 + \tanh(\alpha u_{x,i})] \quad (3)$$

Step 6 : Check stop conditions

D. Simulated Annealing

Simulated annealing (SA) can be used for the search process in optimization cases in discrete and non-existent forms. SA is widely used because of its effectiveness in finding optimal solutions to combinatory optimization problems [21]. The most important part of the SA is an annealing schedule / cooling schedule that determines the rate of decrease in temperature from the level of low temperature setting [22]. What needs to be considered in the cooling schedule process is that if the temperature drops too slowly, the CPU time will be wasted.

The experimental results are shown in Fig 5 and Fig 6. Annealing schedule regulates the decrease in temperature T as a time or iteration function. How to determine annealing schedule is to reduce the temperature T at each iteration. Where is the SA Algorithm for TSP compliance as follows

1. Step 1: Determine the starting point / solution x in the form of vector and initial temperature T, where the iteration starts from k to 1.
2. Step 2: Evaluate objective functions, $E = f(x)$
3. Step 3: Selection of Δx with probability determined by function $g(\Delta x, T)$ Determine the point / solution of the $x_{\text{new}} = x + \Delta x$
4. Step 4: Calculate new values from objective functions: $E_{\text{New}} = f(x_{\text{new}})$

5. Step 5: Determine x as x_{new} and E become E_{New} with a probability determined by the function $h(\Delta x, T)$, where $\Delta E = E_{New} - E$
6. Step 6: Reduce temperature T (determined $T = \eta T$, where η is a constant between 0 and 1)
7. Step 7: $k = k + 1$, if k has the maximum iteration will stop. If you haven't reached the maximum state, repeat step 3.

III. RESULT AND DISCUSSIONS

In completing the TSP with the Hopfield method and Simulated annealing, the first thing to do is to determine a network by locating the problem into a network form, which is a quadratic array. Energy functions for TSP must meet the following requirements:

1. Every city can only be visited once on a trip
2. Each city has a specific order of visits on the track. Two or more different cities may not have the same order.
3. All cities must be visited
4. (If possible) the trajectory is the shortest path.

Determining the efficiency of the Hopfield algorithm and Simulated annealing in solving traveling salesman problems is based on the number of main operations at the average case and the number of the worst case.

A. The Hopfield algorithm

1. Average Case

The amount of work done for input size n , which is concluded $A(n)$, is as follows:

a. Hyperbolic tangent operation

In Hopfield algorithm, in step 5 there is a hyperbolic tangent function, where

$$\tanh(\alpha u_i) = \frac{e^{\alpha u_i} - e^{-\alpha u_i}}{e^{\alpha u_i} + e^{-\alpha u_i}} \quad (4)$$

Thus the highest type of operation in this algorithm is exponential operation. Exponential basic operations are as follows:

$$\begin{aligned} A(n) &= \sum_{I \in D_n} p(I) t(I) \\ &= 1 * (4n^4 + 16n^3) \\ &= 4n^4 + 16n^3 \end{aligned} \quad (5)$$

b. Multiplication Operations

In the multiplication operation, the element calculated is the number of the basic operation for multiplication, in which $t(I)$ is the number of basic operations of multiplication and $p(I)$ is the probability for input I . Because the input type is only one then $p(I)$ is 1

$$\begin{aligned} A(n) &= \sum_{I \in D_n} p(I) t(I) \\ &= 1 * (6n^4 + 24n^3 + 5n^2) \\ &= 6n^4 + 24n^3 + 5n^2 \end{aligned} \quad (6)$$

c. Addition Operations

In the addition operation, the element calculated is the number of the basic operation for addition, where $t(I)$ is the sum of the basic operations of addition and $p(I)$ is the probability for input I . Because the input type is only one then $p(I)$ is 1.

$$\begin{aligned} A(n) &= \sum_{I \in D_n} p(I) t(I) \\ &= 1 * (5n^4 + 12n^3 - 8n^2) \\ &= 5n^4 + 12n^3 - 8n^2 \end{aligned} \quad (7)$$

2. The number of the worst case

The number of the worst case is calculated by determining the conditions causing the biggest basic case. For this problem the condition is never found because the input type is only one. Moreover, because of the highest value of three exponential basic operations that have the highest value, the number of the worst work is equal to the average of the exponential operations, namely:

$$\begin{aligned} W(n) &= \max_{I \in D} t(I) \\ &= 4n^4 + 16n^3 \end{aligned} \quad (8)$$

From this algorithm, the variable used to store the input is array w , n which states the number of array elements, p as the abscissa and q as the ordinate. The memory used to store input is $f(n) = (2n + 7) * k$. In addition, there are extra variables including v_{ij} , u_{ij} , i and j . The memory used to store this extra variables is $f(n) = (n^4 + n^2 + 1) * k$, where k is a constant indicating the type of variable used. Hence, the size of memory to store extra variables depends on the size of the input. The experimental results are shown in Fig 3 and Fig 4.

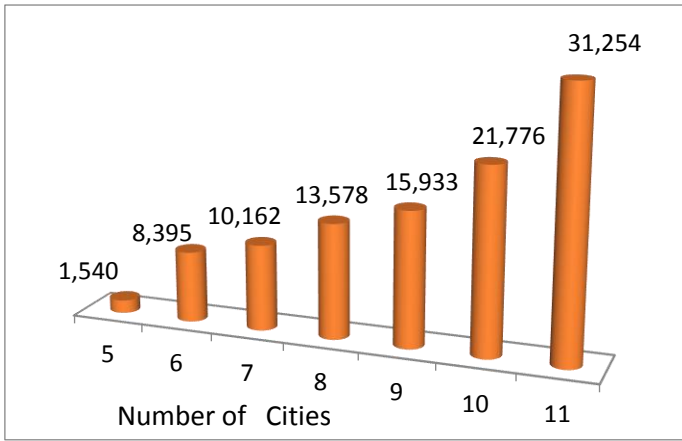


Fig. 3. Graph of test results, the relationship of the number of cities with the number of iterations using Hopfield Algorithm

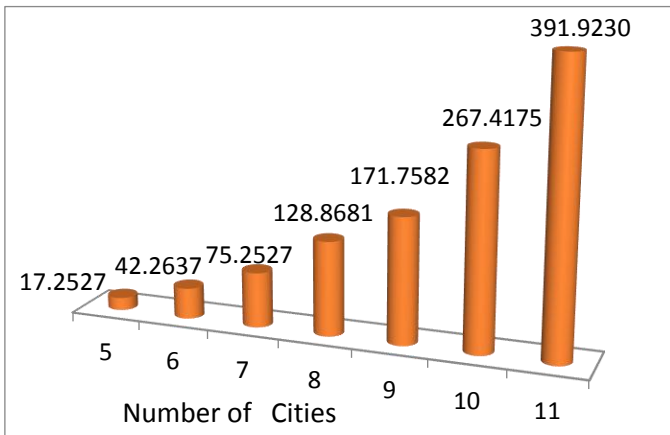


Fig. 4. Graph of test results related to the number of cities with running time (seconds) using Hopfield Algorithm

B. Simulated Annealing

1. Average Case

The amount of work done for input size n , which is concluded $A(n)$ is as follows:

a. Exponential Operation

In this exponential operation that is calculated is the amount of exponential base operations. Because the input type is only one, the $A(n)$ value is: $10n^2$

b. Multiplication Operations

In the multiplication operation calculated is the magnitude of the multiplication base operation, and because the input type is only one, the $A(n)$ value is: $70n^2 + 10n$

c. Operation

In the sum operation, what is calculated is the sum of the basic operations of the sum and because the type of input is only one, the value of $A(n)$ is: $350n^2$

2. Number of Worst Case

Much of the worst work can be calculated by determining the conditions that cause the biggest basic work, for this problem the condition is never found, because the input type is only one. And because of the three exponential basic operations that have the highest value, then the worst amount of work is equal to the average of exponential operations. So that is the worst case of the Hopfield algorithm, namely:

$$W(n) = \max_{I \in D} t(I) \quad (9)$$

$$= 4n^4 + 16n^3$$

The worst case of the Simulated Annealing algorithm is $10n^2$

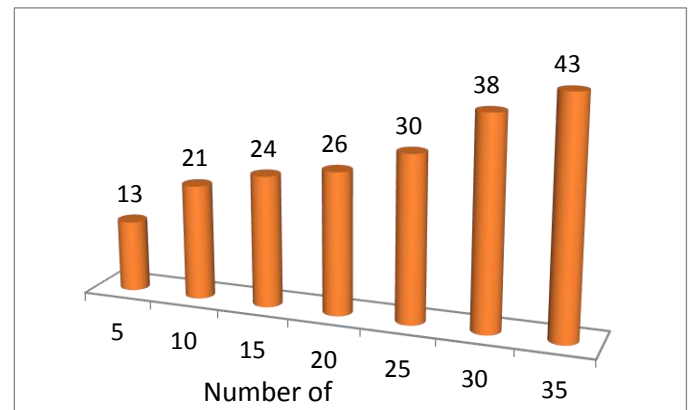


Fig. 5. Graph of the results of the trial of the SA Algorithm in relation to the number of cities with the number of iterations

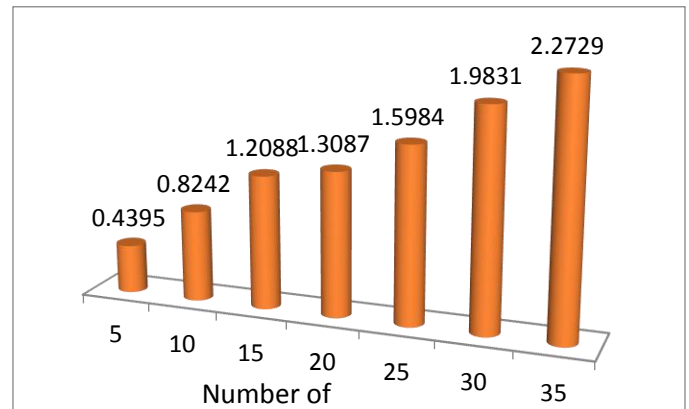


Fig. 6. Graph of the results of the trial of the SA Algorithm in relation to the number of cities with running time (seconds)

IV. CONCLUSION

From the two algorithms discussed, the Simulated Annealing algorithm is the most optimal way to complete TSP. Hopfield algorithm has a fundamental weakness, which is very dependent on the value of the coefficients. Where there is no exact set of coefficients to get the best solution. So the most widely used method is trial and error algorithm. The amount of extra space used to store in the memory of the two algorithms depends on the size of the input, so this algorithm is said to be "no works in place"

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Application of Model View Controller Architecture in Hospital Inventory Logistic Management

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Abstract—An inventory control system is a system to determine stock inventory at a certain time. This happens because there are several problems, namely the difficulty in finding out information on requests, receipts, usage, and stock of consumables. This happens because the data is not stored in a good file and the management of inventory data is still done manually using an inventory card. The process of checking the supply of goods in the warehouse is still single user so that when doing stock inventory the inventory cannot be used multiusers so that the service and Logistics Head cannot directly access the stock opname report. Problems like this require a computerized system and use a multiuser system. The system development methodology used in this research is the waterfall method which includes needs analysis, design, implementation, testing and maintenance. Inventory Logistic Management System is the right solution, which is by combining web-based applications with the Model View Controller (MVC). The purpose of this study using MVC is to see the level of effectiveness of MVC use and measure the level of user satisfaction. The results of this research are the ease of software development and maintenance and user satisfaction with an average survey value of 7.96 and a trial of a system that works well. This application can significantly simplify the work flow of goods distribution and report the distribution of goods in the Hospital. From this research, the authors contributed to the use of MVC which facilitated the implementation, development and maintenance of software and supported by the results of user satisfaction.

Keywords—MVC Model; inventory logistic; user satisfaction

I. INTRODUCTION

RSUD dr. H. Slamet Martodirdjo has a logistics warehouse, which serves as a storage, data collection and distribution of various items needed for hospital operations. In the logistics warehouse there are various items, such as office stationery (ATK), cleaning equipment, printing, household appliances, and many others. So that the hospital needs a good recording system so that the items contained in the logistics warehouse can be recorded properly. The complexity of work in the logistics warehouse causes the hospital to provide a small amount of resources for logistics warehouse operations.

To provide hospital resources requires a small budget. But the limited source of funds for the logistics warehouse caused the hospital to suppress operations in the logistics warehouse. In addition, the demand system and manual recording of items

causes more workload for Warehouse Administrators. The complexity of the workflow in the logistics warehouse has raised problems that are also very complex. As a solution to the complex problems that occur in the logistics warehouse, researchers have designed a logistics management system so that each user in the workflow in the logistics warehouse can work efficiently, quickly and accurately.

The system built has implemented the MVC (Model View Controller) concept. The MVC concept was chosen because it was able to provide convenience to researchers to design a good system with limited resources. In addition, users can use the system easily because it has been designed as well as possible. With the implementation of this system will be able to reduce the workload for Warehouse Admin and all other users who have a role in the workflow in the logistics warehouse.

MVC is a typical paper architecture model that develops the advantages of the MVC pattern, discusses the development process based on MVC software patterns, and designs a Web application-library management system [1]. In some studies the use of MVC has resulted in several conveniences in building software systems. In a study produce the complexity of the code in software can be significantly reduced and increase the flexibility and modularity of software systems [2]. Implementation of the Model-View Controller Framework In the Lampung University Academic Information System produces consistency between views with a flexible interface approach and can represent information in various forms [3].

Application of Model View Controller (MVC) Architecture in the Design of Extensions A Content Management System results in increased modularity and reusability of the system. Source code becomes neater and the separation between business logic and more explicit user interface [4]. E-Commerce Website Using View Controller Models With Codeigniter Framework. With MVC Architecture implemented with this Codeigniter Framework, applications become easier to develop by the next programmer [5]. Comparison of MVC Framework (Codeigniter and Cakephp) on web-based applications can be concluded that to create a web trusteeship in the Informatics Department of the framework of a good National Institute of Technology using codeigniter and for further development using the cakephp

framework because the architecture in cakephp reflects pure MVC [6].

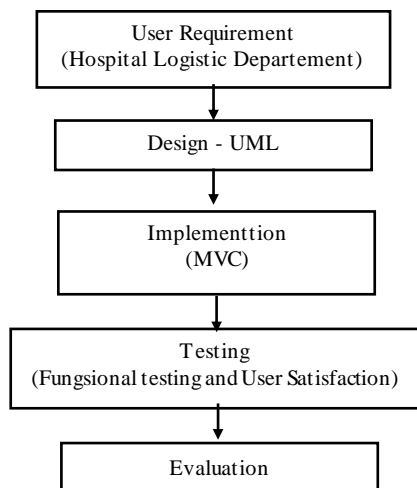


Fig. 1. Riset Structure

The method used in designing and implementing software is to use the Waterfall model. In this model the process runs sequentially from one phase to the next [7]. Each schedule of the phase is completed within a certain time. Documentation and testing occur at the end of each phase to help maintain the quality of the project. Each step will be finalized before heading to the next phase. Figure 1 shows the structure of the research that has been carried out.

II. METHODS

The method used in this study is the waterfall model using the waterfall development process method. This model is a classic model that is simple, structured and linear because the process just flows from beginning to end. This model provides a systematic and sequential approach [8].

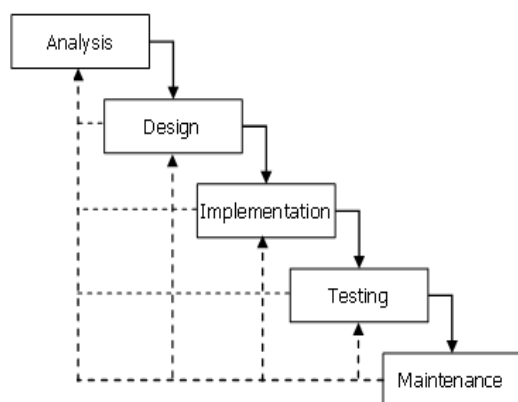


Fig. 2. Waterfall Model[9]

In the Analysis phase, the software developer makes a description of the system to be developed [10]. In this process, the collection of all information needs is taken from the client, in this case the data was taken from the RSUD hospital. dr. H. Slamet Martodirdjo. Collection of system requirements what to do or how to do. There are two types of needs that will be

identified. The first type is functional needs that capture what the system. The second type is non-functional needs that capture the constraints on the system itself, as well as the constraints faced by the system in the development stage. Each functional and non-functional need is analyzed in detail. Object-oriented analysis techniques have been chosen to further identify the system requirements that are detailed using UML (Unified Modeling Language). System requirements are translated into graphical notation using UML. Each use case is associated with an actor, so that each use case states the purpose of the actor in using the system. It also shows the interaction between the actor and the system.

System design stage, technical design starts to be defined which contains detailed designs for each use case. All use cases presented in the analysis phase will be detailed and presented in three diagrams namely sequence diagrams, class diagrams, and activity diagrams. Sequence diagrams are used to describe interactions that are arranged in a time sequence. Class diagrams are used to model the classes to be used, which will later also be transformed in the form of tables of a database as a place to store data, while activity diagrams to model the processes that take place in this adaptive online quiz system. Database design is described as a form of data modeling and user interface design will also be described in this stage as a form of system interface with users [9].

Implementation using the MVC architecture is that it will create data models to represent information from the database, view to display data, and a controller that will combine the two together and handle other tasks. The MVC concept looks like Fig. 2 below.

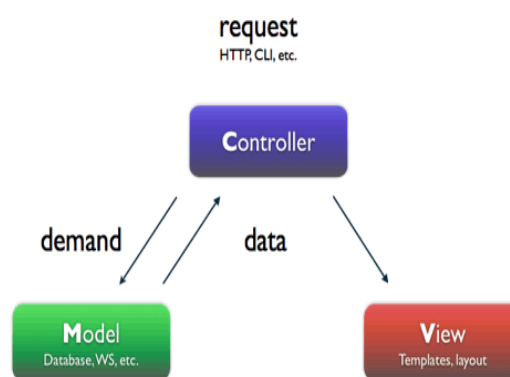


Fig. 3. MVC Model[11]

Logistic Information Management testing is carried out with the aim to find out the compatibility between system functions or services that are implemented with the results of the needs analysis that has been determined at the functional and non-functional needs analysis stage. Testing is also conducted to find out whether the system can be accessed using several internet browser software. Besides that, by doing the testing, it can be seen that there are errors in the coding process and in producing the output of the program so that these errors can be corrected.

III. RESULTS AND DISCUSSION

At the Analysis Stage the collection of information on the procurement of goods in the logistics of the hospital, each room submits a request for goods needed in their room to the head of the department or head of their respective fields. Then the task of the head of the department and the head of the field is to approve the request for goods submitted every room in the hospital. After being approved by the section head or field head, the next process is signed by the planning department. The task of the planning section is to send a request file for goods that have been signed by the planning department and the hospital director to the supplier.

The supplier receives the goods request file from the hospital, collects the goods on demand and sends the goods to the logistics department which is directed directly to the PPHP (the Work Recipient Committee). Arriving at PPHP, the Committee checks the items that have arrived. See the condition of the goods demanded and calculate the number of items according to the request. PP (Administrative Assistance) Goods receive and store items according to their place. And PP Goods provide file data of goods entered into the logistical admin to be recorded on the inventory card.

In the process of distributing goods in hospital logistics, there are stages. The first stage of the head of each room must fill out a card requesting the goods containing the details of the items to be submitted to PPTK (Activity Technician). After completing the item request card, PPTK signs a request card that contains the name of the item submitted to the logistics. PP (Administrative Assistants) The goods fill in the list of items requested in each room. After filling in, the sheet is signed and the item is prepared. Then PP Goods provides

a list of goods requests to the admin logistics to record the items out on the inventory card.

At the design stage, information about the data flow that comes from the user, from the part of the hospital, is made usecase diagrams, activity diagrams, sequence diagrams and CDM and PDM. This is adjusted to the flow of information obtained from the analysis phase.

The system that has been designed is then implemented into the program code using the PHP programming language with Codeigniter as its framework. This section will present a sourcecode to demonstrate the application of the MVC concept to the main features of the logistics management system.

The model is used for data manipulation of goods. It shows in figure 4. This part of source code serves to interact directly with the database used in the system. There are several main functions that function in data manipulation.

The view in figure 5 on MVC only contains codes that function to form a user interface for the system. This source code is a piece of HTML code to display menus from the system. Files from this source code are located in the views folder. In order for the system to use this source code, the researcher needs to make a control that can control the entire source code, both model and view.

On the part of source code from this controller that show in figure 6, there is a function construct that functions to load the model for system requirements. There is also a render page function that functions to load the views needed by the system.

```
public function getData($id = null){
    if($id != null){
        $this->db->where('id_barang',$id);
    }
    return $this->db->get('barang')->result();
}
public function getDataWhere($data = null){
    return $this->db->get_where('barang',$data)->result();
}
public function getDataWhereOne($data = null){
    return $this->db->get_where('barang',$data)->row();
}
public function insert($data = null){
    $this->db->insert('barang',$data);
}
public function update($data,$id){
    $this->db->where('id_barang',$id);
    $this->db->update('barang',$data);
}
public function delete($id){
    $this->db->where('id_barang',$id);
    return $this->db->delete('barang');
}
public function max_id()
{
    $maxid = 0;
    $row = $this->db->query('SELECT MAX(id_barang) AS `maxid` FROM barang')->row();
    if ($row) {
        $maxid = $row->maxid;
    }
    $maxid=$maxid+1;
    return $maxid;
}
```

Fig. 4. Script Model to manipulate goods

System testing is carried out to determine how well the system is operating and in accordance with its function. System testing is carried out by users who only have access rights to the system. Users who have system access rights include Admin Room, Head of Office , Planning Departement, Head of Room and Warehouse Admin.

```
<ul class="nav nav-list">
<li class="active">
<a href="php echo base_url() ?&gt;home"&gt;
&lt;i class="menu-icon fa fa-tachometer"&gt;&lt;/i&gt;
&lt;span class="menu-text"&gt; Home &lt;/span&gt;
&lt;/a&gt;
&lt;b class="arrow"&gt;&lt;/b&gt;
&lt;/li&gt;

&lt;li class=""&gt;
&lt;a href="<?php echo base_url() ?&gt;supplier"&gt;
&lt;i class="menu-icon fa fa-list-alt"&gt;&lt;/i&gt;
&lt;span class="menu-text"&gt; Suppliers &lt;/span&gt;
&lt;/a&gt;
&lt;b class="arrow"&gt;&lt;/b&gt;
&lt;/li&gt;

&lt;li class=""&gt;
&lt;a href="#" class="dropdown-toggle"&gt;
&lt;i class="menu-icon fa fa-desktop"&gt;&lt;/i&gt;
&lt;span class="menu-text"&gt;Barang&lt;/span&gt;
&lt;b class="arrow fa fa-angle-down"&gt;&lt;/b&gt;
&lt;/a&gt;
&lt;b class="arrow"&gt;&lt;/b&gt;
.....</pre

```

Fig. 5. Script View to display the menu

With the system testing, it can be seen the suitability of features with user needs, bugs in the system will be seen so that they can be fixed immediately. In testing this system is directly operated by the user concerned and also by distributing questionnaires to users who have access rights to the system.

The system testing scenario is carried out by distributing questionnaires to users of RSUD. dr. H. Slamet Martodirdjo who has an account to access inventory logistics applications. Questionnaires are given to users who have access rights in the system. The user is the Head of Room, Room Admin, Head of Division, Planning Departement, Section Head, and Warehouse Admin.

The assessment for the questionnaire that has been filled in by the user will be processed further by doing the following process:

1. Calculate the average for each variable.
2. Grouping the results of the calculation of each variable into three categories, namely:
 - a. Good, if the average value is > 7.5
 - b. Enough, if 7.5 => average => 5.0
 - c. Less, if the average value is <5.0

From the results of the questionnaire distributed to users, the value data contained in Table 1.

```
public function __construct(){
parent::__construct();
if($this->session->userdata('id') == '' ){
redirect('/');
}
$this->load->library('session');
$this->load->model('m_barang');
$this->load->model('m_penerimaan_barang');
$this->load->model('m_supplier');
$this->load-
>model('m_detail_barang_masuk');
$this->load->model('m_barang_keluar');
$this->load-
>model('m_detail_barang_keluar');
$this->load->model('m_user');
}
function render_page($content,$sidebar, $data =
NULL){
$data['header'] = $this->load-
>view('master/header', $data, TRUE);
$data['sidebar'] = $this->load-
>view('menu/'.$sidebar, $data, TRUE);
$data['content'] = $this->load->view($content,
$data, TRUE);
$data['footer'] = $this->load-
>view('master/footer', $data, TRUE);
$this->load->view('master/main', $data);
}
.....
```

Figure 6. Script Controller for loading

Based on the results of the questionnaire distributed to users can be obtained the following calculation values:

1. Ease of access to Logistic Inventory Management System = 8
2. Interface Design Logistic Inventory Management System = 8.1
3. Ease of obtaining information on stock items = 7.4
4. Clarity of information and data available = 7.6
5. Completeness of existing information and data = 7.8
6. Ease of operation of the Logistic Inventory Management System = 7.9
7. Completeness of Logistic Inventory Management System features = 7.7
8. Ease in making reports = 8
9. Security Level of Logistic Inventory Management System = 7.8
10. Assessment of the Logistics Inventory Management System as a whole = 8.5.

From the results of the questionnaire, the calculation of the average value of each variable in table 1 can be obtained from the average assessment results from users working in the logistics department of the RSUD. dr. H. Slamet Martodirdjo as a whole with a value of 7.88. Inventory Logistic Management system is in the good category for the overall variable.

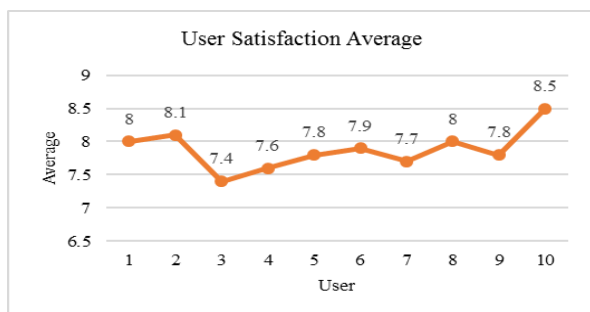


Fig. 7. User Satisfaction Average

Figure 7 is a graph of the average score of user satisfaction. this image makes it easy to read data to draw conclusions. From the results of the questionnaire assessment, it can be concluded that the assessment between users is not much different. this shows the level of objectivity in the assessment process.

At the evaluation stage, data and information come from system testing records. These records are used to improve the overall system. In improving the overall system, the problem does not only come from the previous phase, but can occur in user requirement, analysis, design and implementation phases.

TABLE I. TABLE OF QUESTIONNAIRE RESULTS

No.	Value									
	1	2	3	4	5	6	7	8	9	10
1	8	9	7	8	8	7	7	7	7	8
2	8	7	7	8	8	8	8	7	8	9
3	7	8	8	8	8	9	7	8	7	8
4	7	8	7	7	8	8	8	6	7	9
5	9	9	8	7	7	8	8	8	8	8
6	8	7	7	8	8	7	7	9	8	9
7	7	8	7	8	8	8	8	9	8	8
8	9	8	8	7	8	7	8	9	8	9
9	9	9	8	7	7	9	8	8	9	8
10	8	8	7	8	8	8	8	9	8	9
Average	8	8,1	7,4	7,6	7,8	7,9	7,7	8	7,8	8,5

IV. CONCLUSION AND FURTHER RESEARCH

Based on the results of research, the design of the Logistics Inventory Management System in the RSUD. dr. H. Slamet Martodirdjo can be taken several conclusions that the design of a logistics management system with the application of the MVC Codeigniter concept has been implemented well. In the process of implementing software searches for errors that occur and the development process is quite easy because there is a separation of program code into three groups. These groups are models, views and controllers. By using the concept of developing software MVC, makes the processing of a very complex system processing into simple processing. From the research conducted by the authors contributed to the level of effectiveness of the use of MVC in the implementation, development and maintenance of software. From the results of questionnaires that have been given to the logistics management system users, the overall system is good.

V. ACKNOWLEDGMENT

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Informatics engineering laboratories that assist in providing equipment support and connections to international journals as well as improving the software development methods that have been carried out. The knowledge that has been given will improve the research that has been done. However, this research needs to be improved for more perfect results. So that further research can be done using different data and different methods.

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Design of Automatic Harvest System Monitoring for Oyster Mushroom Using Image Processing

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Abstract— The aim of this study is designing a system which can automatically detects the harvest time of the plant, using data from camera, using image processing. Phase one of our project depends on designing a harvest time decision maker system using image processing. Phase 1, plant grown using Smart greenhouse automation is done. Then, we design integrated system to detect real time harvest time, Ana it is discussed using implementation of IoT and analog devices. In order to detect the harvest time, we use the edge detection algorithms. The result of this study, show quality of the plant, which have 15% of error rate at the left sector, and 20 % of error rate at the right sector.

Keywords— *Smart greenhouse; android; image processing; edge detection; harvest*

I. INTRODUCTION

A specific advantage of the smart greenhouse is that the environment may be controlled in such a way that optimal growing-conditions are obtained. The Smart Greenhouse promise an excelent yields better than in the open field, because of its advantages on climate control. The Smart Greenhouse resulted crops represent a shift from extensive to intensive production. In a smart greenhouse, the plants arrange corresponding to its terms condition. Controlling climate conditions in a greenhouse must be adjusted to the desired conditions. If there is a change in the system, this smart green house must be able to restore the system according to the setpoint again. Its must be able to reduce the surrounding climate disturbances, so that plants can develop in accordance with the conditions set. With this climate change, the sensor will send a report, then the controller responds so that the climate can be controlled like the initial set point.

The main goal of smart green house is so that the conditions in this greenhouse are in accordance with the requirements of the flower plants that are maintained. in this green house sensors are installed, such as temperature, humidity, soil humidity, pH, and CO₂ levels in the greenhouse. the data from this sensor is then read by the system, then becomes input for the controller. by using this controller, the system is then set using an algorithm according to the method used, so the system works perfectly, according to the desired input.

This smart green house automation system promises an effective farming system. Plants that cannot grow in certain areas, can be developed in the area, using smart green house automation. Climates that were previously not achievable

provided that plants grow and produce good crops, can be controlled using sensors and control algorithms. This will produce crops with high productivity, thus helping farmers to increase their yields. Increasing research and development on a variety of sensing, actuation and information technology hardware and software reveals the interest of having automated agriculture parallel to the controlled environment benefits. Greenhouse automation is also associated with better management through process optimization.

One of the aim of the smart green house Technology is the stability of plant production. Green house is in a closed environment, so that all are conditioned to be able to meet the requirements of plant growth. all parameters are controlled, such as temperature, soil humidity, humidity, light intensity, to support the success of plant growth, resulting in a quality harvest. besides that it can also control pests and diseases, so that plants can be protected more. Here, the system is an application oriented. The phase one of our project depends on developing an image processing algorithm to detect harvest time in plants. In step 1 plant grown is done. In phase 2 the embedded system is constructed and a solution for the detected harvest time is discussed using implementation of IoT and analog devices. In the end an application is implemented in the future so that the Iot module sends user about the harvest time and the end using the data to send information to the relay circuit to provide harvest time reminder. So through this research we can directly help the farmer. By using the automated agricultural inspection, farmer can give potentially better and accurate productivity .With the help of this technique, different good quality of crops can be used. [1].

Planting oyster mushrooms requires a lot of attention so that the fungus can develop properly. One aspect of oyster mushroom disease is to provide the right plant environment. If temperature, humidity and freedom are not adequate, our mold blocks will dry out and produce no fruit. We must provide an adequate environment for fungi, one of which is high humidity, especially adequate watering. Although different mushrooms have their own unique environmental requirements, once we have a basic grow area set up you can tailor it to the specific species we are trying to grow. Smart Green House Automation is an embedded system to monitor and control the environment parameters of an oyster mushroom's green house. It is necessary to design a fuzzy control system to monitor various parameters like

Temperature level, Soil moisture level, Humidity level, Light Intensity and CO₂ level]. The main objective of this paper is to design a Smart Fuzzy Green House Automation For Oyster Mushroom Cultivation. The system provides a real time control system which monitors and controls all the activities of the smart greenhouse system perfectly. By continuously monitoring the status of the soil, we can control the flow of water and thereby reduce the wastage. This smart green house automation System also presents the communication interface. The data from the sensor can be sent further for analysis purpose. Using this automation, can save energy, water to increase production and the most important is to increase profit [2].

The aim of image processing project is to recognize objects in a document image segmentation or a complex scene. Edge detection is one of the first steps[3]. Edge detection algorithms can detect an image intensity and/or color with strong transitions. These transitions are characteristic of object edges, region segmentation, text finding and object recognition. Researchers have concentrated in the past few decades on devising algorithms for grayscale image understanding [4]. There are many benefits in using color images. They can make the increase in the quantity of information that can be used for more accurate processing, object location, and the possibility of processing images.

With image processing, we can design a system that follows more closely how the human visual system perceives color objects. To that end, the physical processes that underlie the optical effects have been studied. From the research, the result is derived from a physics-based approach based on the Dichromatic Reflection Model introduced by Shafer in 1985 [5]. Physical processes involved in the image formation stage have not been a strong point of interest in the traditional line of computer vision research [6]. Generally, the proposed algorithm for harvest time image processing has three phase: First, image segmentation process, then object-based analysis process and color features analysis process. Then they sent the data to IoT for the notification.

II. LITERATURE REVIEW

A. Smart Green House

Fig. 1 present a process of Smart Green House Monitoring System. In this Smart Green House Monitoring System the data are collected from the wireless sensor nodes. Next process is to analyze the data for an expert climate control. At this case, we use fuzzy logic in order to optimize water usage and energy consumption. To control the fuzzy logic parameter is used and implemented using Arduino board. The data from different sensors collected to frequently monitor light intensity, humidity, temperature, and soil moisture, in the smart greenhouse. The output from the greenhouse climate is received by the sensor node, it is transmitted to the wireless node through a wireless protocol. This Smart Green House Monitoring System uses nodemcu wireless module for data transmission from the end devices to the web server node. Using the data from the web server node, the farmer can monitor and control the smart greenhouse climate easily using android application.[7].

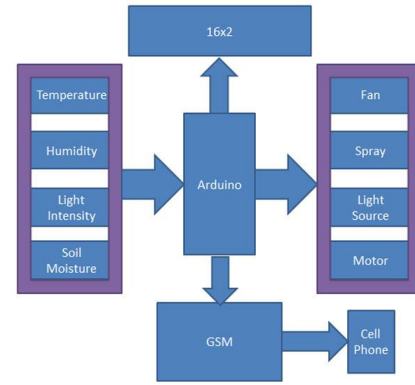


Fig. 1. Process of Smart Green House Monitoring System

B. Edge Detection

In image processing science, edge detection has become an important topic in image management because of its ability to provide appropriate information from images and provide interesting object boundaries. It provide a basic operation to get information about an image, such as its size, morphology and texture. Edge detection technique is showed the most common method to detect significant discontinuities in the values of intensities of an image. The technique is accomplished by taking spatial derivatives of first and second order (using the gradient and Laplacian). This spatial derivatives show the image non smooth changes in the function $f(x,y)$ can be determined with the derivatives equation. The operators that represent edges are particularly expressed by partial derivatives.

By using edge detection, result that consists of binary image the pixels where hard changes have tauke place appear bright, while the other pixels remain dark. A significant degradation on the amount of information, as this output in change permits while defending the important structural properties of the image. The gradient set as the first derivative, which is able to assign a change in the intensity function. It's through a one-component vector (hint) pointing in the hint of maximum growth of the image's intensity. The gradient of a two dimensional intensity function $f(x,y)$ is defined as[17]:

$$\nabla f = \text{grad}(f) = \begin{bmatrix} \frac{\partial f}{\partial x} \\ \frac{\partial f}{\partial y} \end{bmatrix} \quad (1)$$

The magnitude of this vector is:

$$\begin{aligned} \nabla f = \text{mag}(\nabla f) &= \sqrt{g_x^2 + g_y^2} \\ &= \sqrt{\left(\frac{\partial f}{\partial x}\right)^2 + \left(\frac{\partial f}{\partial y}\right)^2} \end{aligned} \quad (2)$$

And the direction is given by the angle:

$$\alpha(x,y) = \tan^{-1} \left(\frac{g_y}{g_x} \right) \quad (3)$$

III. METHODOLOGY

Image processing using edge detection was developed in 1960 and 1970 [8, 9]: Roberts [10], Prewitt [11], and Sobel [12]. these methods are widely used for several different applications. Although many new methods emerge, this simple, old detection method can still be used effectively[13]. In this study, several standard methods of edge detection are carried out gray-level edge detectors for color image processing. Color image processing is explained in this section.

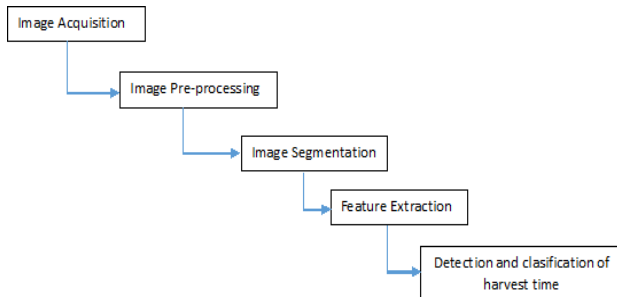


Fig. 2. System Model : Harvest time using image processing

Image Acquisition: In this section, first the camera works. The camera captures the image, and then we analyze the captured image. This process is named image acquisition. Images processed in RGB form, namely red, green, and blue. then applied a separate color transformation structure for captured RGB images. CCD array sensors that are analyzed in the camera, are in the form of a rough array. some digital light sensing instrumentation and digital cameras using CCD sensors. The CCD sensor response is directly proportional to the integral of the energy projected to the sensor, requiring low noise images, such as those of astronomical applications. In order to reduce the noise, we let the sensor integrate with the input light signal over minutes or even hours, until we get the right noise value. Then we can complete the image can be obtained by focusing the energy pattern onto the surface of the array, because the sensor array is two dimensional. [14].

Image Pre-Processing: To get the image region, we crop the plant image. This pre-processing techniques aim is to remove noise in image. then we use smoothing filter to make the image smooth. Its called as image smoothing. In order to increase the contrast, image enhancement is done.

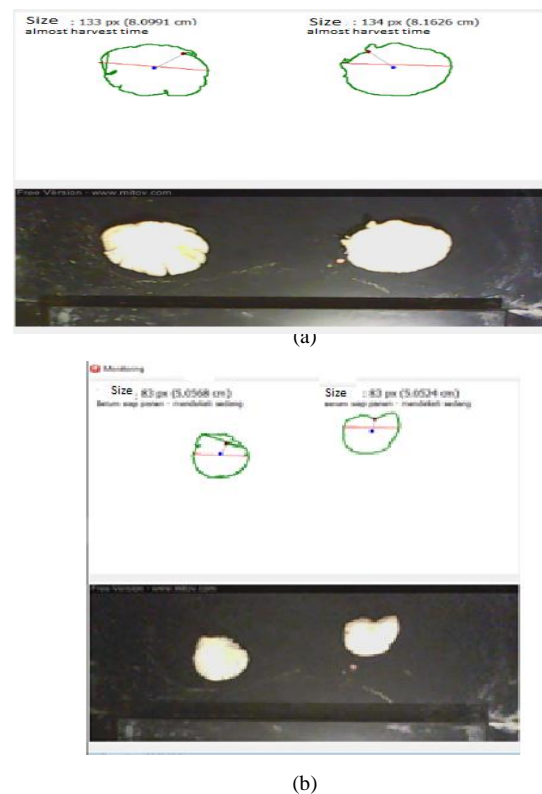
Image Segmentation: The whole image segmented in defect region, its call image segmentation. It may also be used to segment based on same features or certain similarity. this section can also be used for strengthening based on courage or other obstacles. this paper uses the K-mean segmentation with the otsu's threshold method and then converts RGB images into HIS models, etc. In the process of image segmentation, an image is partitioning into meaningful parts. This process is perhaps the most researched and most important topic in image analysis. The image analysis in image segmentation process can be attributed to the importance of segmentation, whith the fact that a universal method does not exist that can segment all images [15].

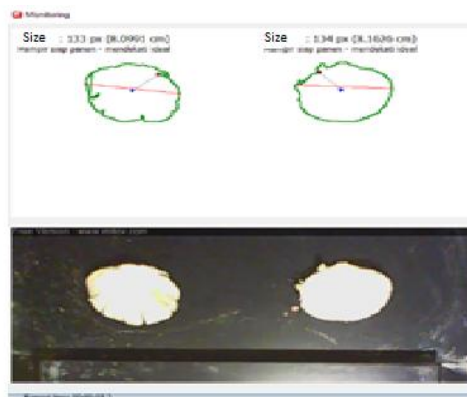
Feature Extraction: In order to identify an object in an image, we use feature extraction. This process plays an important role in the image analysis. In many application of image processing feature extraction is used so that it simplifies the further processing. In plant harvest detection, the variable that can be used are: color of the plant, texture, morphology, edges etc. In harvest detection they think over the variable : color, texture and morphology as a feature for harvest detection. This research have found that morphological result of the feature extraction gives better result than the other features. How the colour is distributed in the image, the roughness, hardness of the image is texture definition [16]. High-level feature extraction attentions how to find shapes in computer images.

According to the output which they generate, several digital image processing techniques have been classified, base on the problem. Then it can be classified base on supervised or unsupervised methods, and base on using crisp or fuzzy techniques. When we use a digital image (such as classification, edge detection, segmentation and hierarchical segmentation), different problems should be formally classified when trying to recognize an object. Color segmentation output and the resulting image is not always appropriate. This detection system can only detect, but no photo objects were found [17].

IV. RESEARCH RESULTS

Fig. 3 show the results of edge detection calculations using software. The resulting value shows an indication of the extent to which digital processing results approach the ideal image.





(c)

Fig. 3. Data Image

Green objects are the result of object image processing, and red lines are used to determine the object's midpoint. The test results for several samples of oyster mushrooms are as follows:

TABLE I. TESTING RESULTS AT THE LEFT SECTOR

NO.	Testing Results At The Left Sector			
	Size on the application (px/cm)	Category	quality	Result
1.	100 / 6,09	HI	A	HSP
2.	120 / 7,3	I	A	SP
3.	125 / 7,6	I	B	SP
4.	110 / 6,6	I	A	SP
5.	116 / 7,1	I	A	SP
6.	97 / 5,9	HI	A	HSP
7.	106 / 6,4	I	A	SP
8.	86 / 5,0	HI	A	HSP
9.	94 / 5,7	HI	B	HSP
10.	73 / 4,4	S	B	BSP

TABLE II. COMPARISON OF MEASUREMENTS BETWEEN APPLICATION AND RULER

No.	Comparison Of Measurements Between Application And Ruler		
	Size on application (cm)	Real Size (cm)	Margin
1.	6.09	6	0.09
2.	7.3	7.5	0.2
3.	7.6	7.5	0.1
4.	6.6	6.5	0.1
5.	7.1	7	0.1
6.	5.9	6	0.1
7.	6.4	6.5	0.1
8.	5.0	5	0
9.	5.7	6	0.3
10.	4.4	4	0.4

By using a tolerance of 0.149 from the data above table, it is known that from 10 oyster mushroom sample tests, the system has failed as much as 3. By using image processing, the presentation of success :

Total Testing : 10, Success : 7, Failed: 3.

Error Rate = $3/(7+3+10) \times 100\% = 0.15 = 15\%$

TABLE III. OBJECT TESTING RESULTS AT THE RIGHT SECTOR

No.	Testing Results At The Right Sector			
	Size on the application (px/cm)	Category	quality	Result
1.	98 / 5,9	HI	B	HSP
2.	96 / 5,8	HI	A	HSP
3.	80 / 4,8	S	A	BSP
4.	128 / 7,7	I	B	SP
5.	96 / 5,8	HI	B	HSP
6.	94 / 5,6	HI	A	HSP
7.	72 / 4,3	S	A	BSP
8.	107 / 6,5	I	A	SP
9.	74 / 4,4	S	B	BSP
10.	104 / 6,3	I	A	SP

TABLE IV. COMPARISON OF MEASUREMENTS BETWEEN APPLICATION AND RULER

No.	Comparison of Measurements Between Application And Ruler		
	Size on application (cm)	Real Size (cm)	Margin
1.	5,9	6.4	0,5
2.	5,8	6	0,2
3.	4,8	5	0,2
4.	7,7	7.5	0,2
5.	5,8	5.5	0,3
6.	5,6	5.5	0,1
7.	4,3	4.5	0,2
8.	6,5	6	0,5
9.	4,4	4	0,4
10.	6,3	6.5	0,2

From the data of the table, it is known that from 10 oyster mushroom sample tests performed, the system has failed as much as 4. By using image processing, the presentation of success is as big as:

Test Total: 10, Success 6, Failed 4.

Precision = $6/(6+4) \times 100\% = 0.6 = 60\%$

Accuracy = $(6+10)/(6+4+10) \times 100\% = (16)/20 \times 100\% = 80\%$

Error Rate = $4/(6+4+10) \times 100\% = 0.2 = 20\%$

Note :

S : Medium

HI : Almost Ideal

I : Ideal

BSP : Not Ready to Harvest yet

HSP Almost ready to harvest

SP Ready to harvest

The result of all the sensors is displayed in LCD through the microcontroller and it sends the message when the threshold goes beyond the certain level to our android phone. In the plant image processing, we are using edge detection to detect the harvest time. The result of the plant image processing is sent to the Programmable Interface Controller (PIC) micro controller. The microcontroller detects the

presence of the signal and sends a message to the mobile via a nodemcu.

V. CONCLUSION

The result of this study, show quality of the plant, which have 15% of error rate at the left sector, and 20 % of error rate at the right sector. This harvest decision-making system in this reseach has not produced optimal results, then it will be tested and read based on color differences. This should be an area of future focus.

VI. SUGGESTION

In order to improve the harvest decision-making system performance, it is better to use especially the sobel and canny edge detection operators for edge detection. [18]. Next we will connect this research with android to get real time monitoring.

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Design Of Modified Microstrip Antenna And 4x1 Microstrip Array For Data Communication At 2.4 GHz Frequency

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Abstract—The use of wireless or wireless communication technology is currently growing rapidly. To establish a wireless communication device, an antenna is needed to send and receive electromagnetic waves or signals during the data transmission process. In this research we undertook simulation, fabrication, parameter and distance testing for data communication at 2.4 GHz frequency. To achieve the above objective, first we made an antenna. The antenna dimensions were designed based on antenna formulas and then simulating with the CST Studio Suite. Second, we fabricated Microstrip antennas senders that could work well in the 2.4 GHz frequency with return loss = -12.06 dB, VSWR = 1.692, impedance = 38.35Ω ohms. While the 4x1 fabricated microstrip array antenna was designed to operate at 2.4 GHz frequency with return loss = -19.41 dB, VSWR = 1.235, impedance = 54.77 ohms. That is, the two microstrip antennas are suitable for use at 2.4 GHz frequency and in accordance with the expected specifications. The test using module Xbee PRO S2C and Xbee S2C. Result showed that communication runs smoothly that is able to send and received data properly..

Keywords—antenna; return loss; impedance, distance

I. INTRODUCTION

The use of wireless or wireless communication technology is currently growing very rapidly. To do wireless communication, an antenna is needed because it functions to send and receive electromagnetic signal waves. In data communication between 2 antennas, an RF (Radio Frequency) module is needed. This data communication test is to determine the distance of the antenna range that is fabricated as a signal amplifier and analyze the telemetry performance system.

Telemetry is a communication system for the transfer of remote measurement data that uses transmission media as a data carrier. In other words, it can be said that telemetry is an automatic communication process that is used to measure and retrieve data at a location that is far away to be transmitted to the data processing center [1]. Telemetry sistem influence by antenna wehere proper antenna selection, good design and correct installation will guarantee the performance of the system. The problem that often occurs is that the transceiver antenna cannot work optimally for a considerable distance.

In this study is designed, simulation, fabrication, antenna parameter testing using VNA (Vector Network Analyzer) and

antenna range test. Single patch microstrip antennas that are modified to obtain omnidirectional radiation patterns are recommended as sending antennas because they are easy to manufacture, inexpensive, small and light dimensions so that they are suitable to be applied on a moving device [2]. While yagi antennas and 4x1 microstrip array antennas (have more patches) are chosen as the receiving antenna for comparison because they are equally directional, which means the direction of the beam is focused in one direction and tends to have a large gain compared to omnidirectional so that it can receive signals with a sufficient distance range in a loss condition (without obstruction) if it is focused on the sending antenna.

In the previous research conducted by Alam, et al [3], in his journal entitled "Rancang Bangun Antenna Mikrostrip Peripheral Slits Linear Array Untuk Aplikasi Wi-Fi (Building Design of Peripheral Microstrip Antenna Linear Array for Wi-Fi Applications)". The measurement results of the composition of the four elements of peripheral slits obtained a bandwidth of 150 MHz (2.424 GHz-2.574 GHz) with a percentage of bandwidth of 6.12%. Measurement results at the middle frequency of 2.448 GHz obtained a return loss of -16.88 dB with a VSWR of 1.304.

Pasaribu, et al [4] on his journal entitled "Rancang Bangun Antena Mikrostrip Patch Segiempat Pada Frekuensi 2, 4 Ghz Dengan Metode Pencatutan Inset (Design of Patch Rectangular Microstrip Antenna at Frequency of 2, 4 Ghz with the Inset Imaging Method)". Based on the results of the antenna bandwidth obtained at 112 MHz (2.388 - 2.5 GHz) in VSWR ≤ 2. At the middle frequency of the antenna (2.45 GHz) obtained return loss of -14.77 dB, VSWR of 1.45, radiation pattern unidirectional, and gain 6 dBi.

Joni, et al [5] entitled "Pengujian Jarak dan Waktu Gabung Protokol IEEE 802.15. 4 / ZigBee di Lingkungan Indoor (Protocol IEEE 802.15. 4 / ZigBee Distance Test and Join Time in the Indoor Environmen)." The results showed that the pairing method can be done long distances to the outside of the building with a distance of about 65 meters, while the distance using the On / Off method can reach several rooms in the indoor area. The longest time to join takes about 1 minute 15 seconds.

According to Qun, Deng Et al [9]. “Design and simulation of the microstrip antenna for 2,4 Ghz HM remote control system”, showed that antenna model simulated in ADS and obtained the requirement parameter through optimizing and matching.

II. THEORY

A. Microstrip Antenna

Based on the origin of the word, microstrip consists of two words, namely micro (very thin / small) and strip (slats / pieces). Microstrip antennas can be defined as one type of antenna that has a shape like a blade or a piece that has a very thin or small size[2].

B. Dimensions of the Microrip antenna

In designing a microstrip antenna using CST Studio Suite 2016 software, the antenna dimensions are determined in advance based on the calculation of the antenna formula. The frequency and specifications of the material to be used are the main factors in the calculation of antenna dimensions.

The basic structure of a microstrip antenna consists of a radiating element or commonly called an conducting patch, substrate element (dielectric substrate), and grounding element. The size of the irradiation or patch element is obtained from the following equation [2]:

Patch width (W) can be calculated by the equation [2] :

$$W = \frac{C}{2f_0 \sqrt{\frac{(\epsilon_r + 1)}{2}}} \quad (1)$$

W= patch wide (mm)

c = Light speed (3 x 10⁸ m/s)

f₀ = Resonance Frekuensi (Hz)

ε_r = permittivity / constant dielectric

Whereas Patch Length (L) can be calculated by the equation [2] :

$$W = \frac{C}{2f_0 \sqrt{\frac{(\epsilon_r + 1)}{2}}} \quad (2)$$

Where is the effective length obtained from the equation:

$$L_{eff} = \frac{c}{2f_0 \sqrt{\epsilon_{reff}}} \quad (3)$$

In calculating L_{eff} it must be known ϵ_{reff} For ϵ_{reff} can be calculated by the equation[2] :

$$\epsilon_{reff} = \frac{\epsilon_r + 1}{2} + \left(\frac{\epsilon_r - 1}{2} \right) \chi \sqrt{\frac{1}{1 + \left(\frac{12h}{W} \right)^2}} \quad (4)$$

And for increasing length (ΔL) can be calculated by the equation [2] :

$$\Delta L = 0,412 \cdot h \cdot \frac{\left(\frac{\epsilon_{reff} + 0,3}{\epsilon_{reff} - 0,258} \right) \left(\frac{W}{h} + 0,264 \right)}{\left(\frac{W}{h} + 0,8 \right)} \quad (5)$$

Next look for the dimensions of the feeder (transmission line). Feeder width (Wf) can be calculated by the equation [6]:

$$B = \frac{60\pi^2}{Z\sqrt{\epsilon_r}} \quad (6)$$

$$Wf = \frac{2h}{\pi} \left\{ (B - 1 - \ln(2B - 1)) \right\} + \frac{\epsilon_r - 1}{2\epsilon_r} \left\{ (\ln B - 1) + 0,39 - \frac{0,61}{\epsilon_r} \right\} \quad (7)$$

While the length of the feeder (Lf) can be written with the equation [6]:

$$\Delta g = \frac{\lambda}{\sqrt{\epsilon_{reff}}} \quad (8)$$

$$Ls = \frac{1}{4} \lambda \quad (9)$$

Next look for groundplane dimensions. The groundplane on the microstrip antenna serves to separate the dielectric substrate from other objects that can interfere with signal radiation.

Groundplane Width Dimensions (Wg) can be calculated by the equation [7] :

$$Wg = 6h + W \quad (10)$$

As for the groundplane length (Lg) can be calculated by the equation:

$$Lg = 6h + L \quad (11)$$

The distance between the elements on this antenna is $\lambda / 2$ with a constan [2]

$$\lambda = \frac{c}{f} \quad (12)$$

Required specifications

TABLE I. MATERIAL ANTENNA SPECIFICATION

Copper	Spesification	
	Relative Permittivity (ε _r)	Thickness
Copper	1	0,035 mm
FR4 Epoxy (substrate)	4,3	1,6 mm

TABLE II. ANTENNA SPECIFICATION PARAMETER

Parameter	Value
Frequenzy	2,4 GHz
Strenght	< -10 db
Return Loss	< 2
VSWR	50 Ohm

Table II Material that used to make antenna with required parameter at Table II.

C. Techniques For Microstrip Antenna Recording

The feed technique used is the Microstrip line feed technique. This technique is one popular, simple and easily fabricated technique is a line feed technique, but this technique results in a bandwidth that is not wide and the gain is not so large [8].

III. RESEARCH METHODS

A. Flowchart

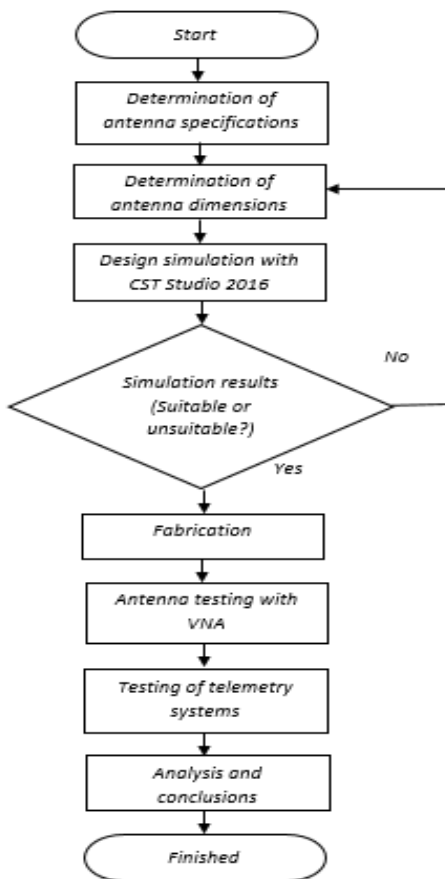


Fig. 1. Flowchart

The initial stage of the research is to study literature about the antenna to be made. Determine the required material specifications and antenna parameters and the dimensions of the antenna based on the antenna formula. Then design by entering the dimensions and simulating the CST Studio Suite 2016.

software simulation results in the form of antenna parameters that affect the performance of the antenna (Fig 1). The parameters taken as a reference here are the matching parameters, namely VSWR, Return Loss and impedance. If the simulation results are not in accordance with the expected antenna specifications, it is necessary to optimize the simulation by changing the antenna dimensions slightly and modifying the shape. If the simulation results are appropriate, then fabricated and tested for feasibility with a VNA device. After this stage, direct distance testing or telemetry system implementation is carried out.

B. Telemetry System Block Systems

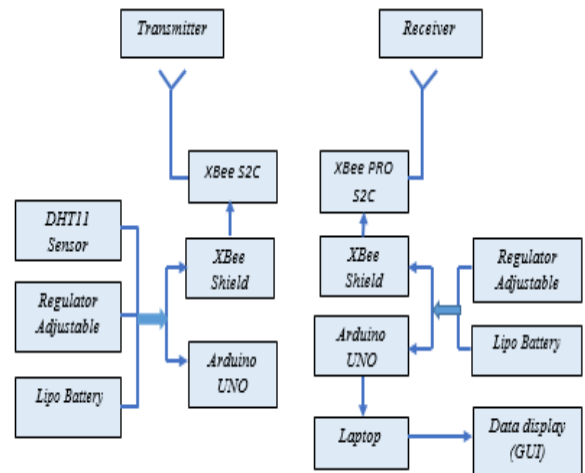


Fig. 2. Telemetry System Block Diagram

The working principle of this telemetry system is sending data in the form of temperature using a DHT11 sensor, then processing the data by Arduino. In this telemetry system lipo batteries are used as a voltage source and adjustable regulator as a voltage regulator / stabilizer. The transmitter and receiver modules used are Xbee modules that work on the 2.4 GHz frequency. Modified microstrip antennas are used as sending antennas, while receiver antennas are used microstrip array antennas installed in GCS (Ground Control Station) and connected to laptops. The test can determine the maximum range of the antenna can send or receive signals

IV. RESULT AND DISCUSSION

A. Sender Microstrip Antenna

The designed sender microstrip antenna is expected to have an omnidirectional radiation pattern. Therefore, at least 2 substrates must be needed, namely FR4 Epoxy double layer and single layer. The patch model that is designed is rectangular then modified by adding parasitic and adjusting the antenna dimensions.

The following is an optimized table of antenna dimension calculation.

TABLE III. OPTIMIZED SENDER MICROSTRIP DIMENSIONS

Antenna Dimension	Value (mm)
Patch Width (W)	40
Patch Length (L)	34
Gpf	0,2
patch feeder width (Wf)	1,404
patch feeder length(Lf)	15
Patch radius	8
Substrate width (Ws)	47
substrat length (Ls)	80
ground width (Wg)	22
ground length (Lg)	40
feeder ground width (Wfg)	3,038
feeder ground length (Lfg)	40
Slot radius	12

1) Simulation Test

Antenna works well at a frequency of 2.4 GHz with return loss = -33.45 dB, VSWR = 1.043, impedance = 50 ohm, gain = 2.207 dB. This antenna is expected to have an omnidirectional radiation pattern (emission in all directions) because it will be applied as a sending antenna, but the simulation results of this antenna are still bidirectional radiation pattern (two-way beam). The parameter simulation results are shown in Fig 3,4,5,6.

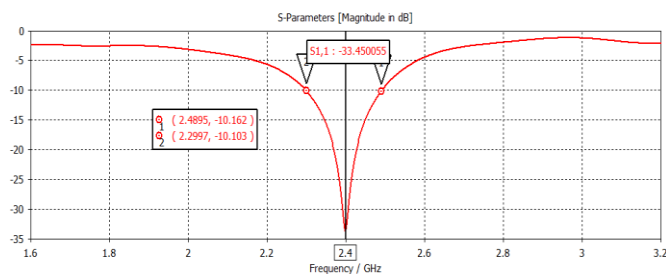


Fig. 3. Return Loss Simulation Results of Sender Microstrip Antenna

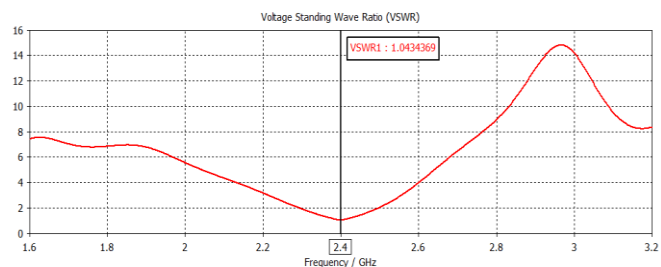


Fig. 4. VSWR Simulation Results of Sender Microstrip Antenna

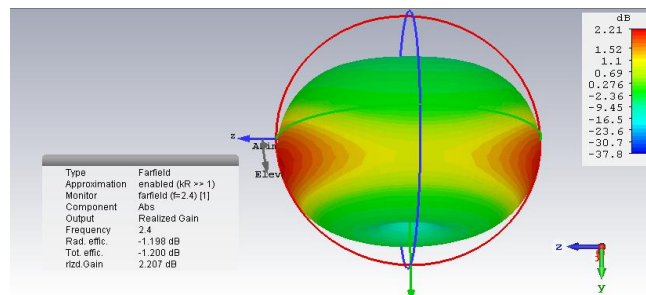


Fig. 5. Gain Simulation Results of Sender Microstrip Antenna

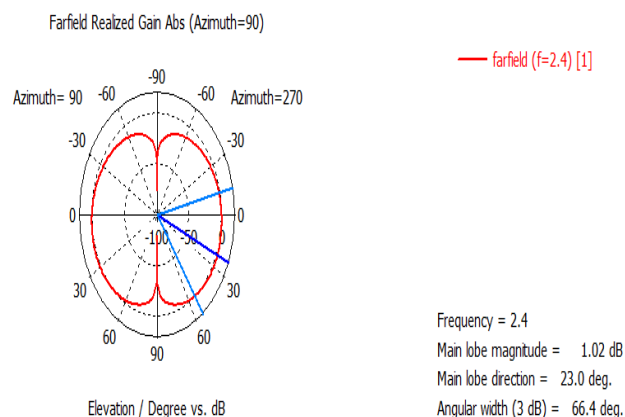


Fig. 6. Results of Simulation of Sender Microstrip Antenna Radiation Pattern

2) Fabrication results of Sender Microstrip Antenna

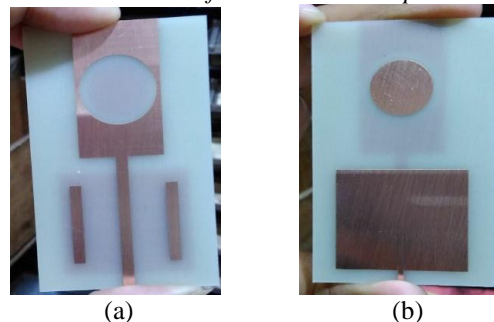


Fig. 7. (a) Sending Microstrip antenna front and rear with 2 substrates (b) Sending Microstrip Antenna patch parts

3) Sending Microstrip Antenna patch parts

The fabricated sender microstrip antenna is able to work at 2.4 GHz frequency with return loss = -12.06 dB, VSWR = 1.692, impedance = 38.35 Ω \square 24.70. This means that the antenna that is fabricated is in accordance with the expected specifications. But for impedance does not match the cable impedance used is the RG58 50 Ω coaxial cable. Bandwidth or working area of this antenna is 282 MHz between the frequency of 2,298 GHz - 2,580 GHz. Test results with VNA are shown in Fig 8,9,10.

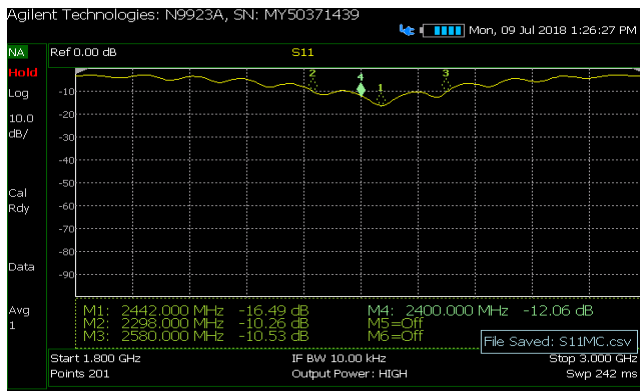


Fig. 8. Results of Return Loss Testing with VNA in Sender Microstrip Antenna

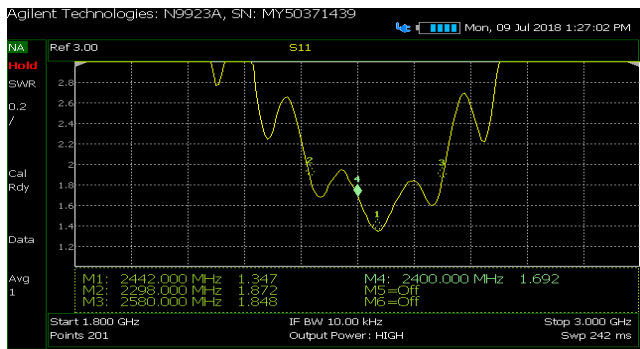


Fig. 9. Results of VSWR Testing with VNA in Sender Microstrip Antenna

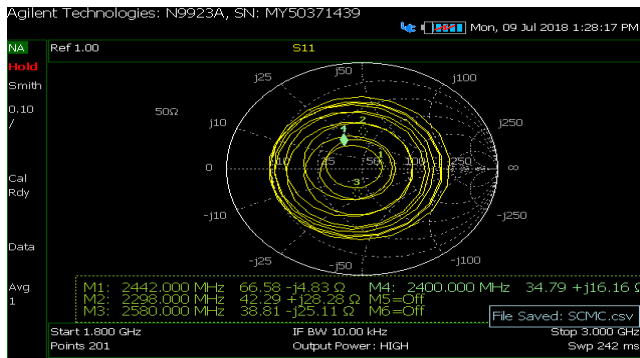


Fig. 10. Results of Impedance Testing with VNA in Sender Microstrip Antenna

B. 4x1 Array Microstrip Antenna

The designed 4x1 microstrip array antenna is applied to the receiver side in GCS (Ground Control Station) and is expected to have unidirectional radiation patterns.

The following is a table resulting from the calculation of the antenna dimensions that have been optimized.

TABLE IV. DIMENSIONS OF ARRAY ANTENNAS THAT HAVE BEEN OPTIMIZED

Antenna Dimension	Value (mm)
Patch Length (L)	38
Lebar Width (W)	29
Inset Length (Li)	8,85

Antenna Dimension	Value (mm)
Inset Width (Gpf)	1
Feeder Width (Wf) 50 Ω	3,137
Feeder Width (Wf) 70 Ω	1,677
Substrat Length & Ground (Lsg)	315
Substrat Width & Ground (Wsg)	80,51
Distance Patch 1&2	35
Distance Patch 2&3	62,5
Distance Patch 3&4	35

1) Simulation Testing

Antenna works at 2.4 GHz frequency with return loss of -50.44 dB, VSWR of 1.035, impedance of 49 ohms, and gain of 6.362 dB and has a directional radiation pattern. The parameter simulation results are shown in Fig 11,12,13,14.

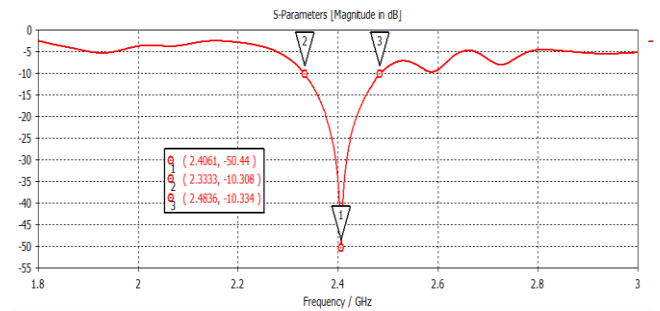


Fig. 11. Return Loss Simulation Results of 4x1 Array Microstrip Antenna

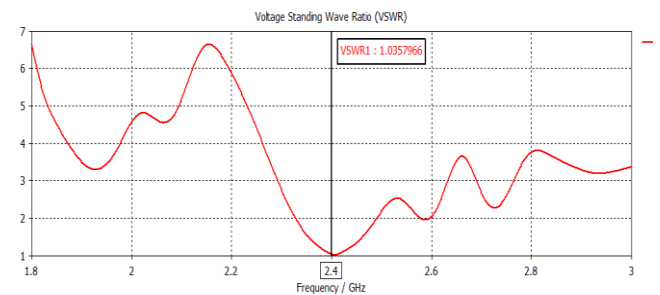


Fig. 12. VSWR Simulation Results of 4x1 Array Microstrip Antenna

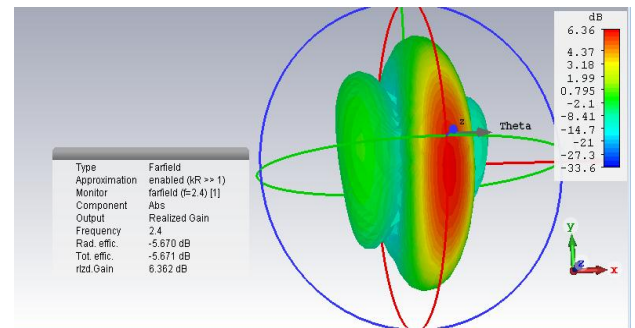


Fig. 13. Gain Simulation Results of 4x1 Array Microstrip Antenna

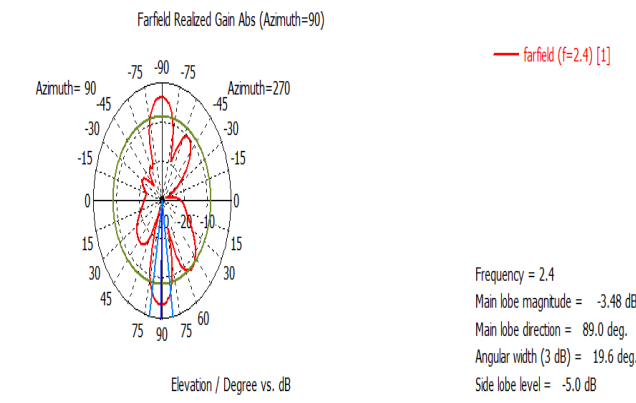


Fig. 14. . Results of Simulation of 4x1 Array Microstrip Antenna Radiation Patterns

2) Fabrication Results Of 4x1 Array Microstrip

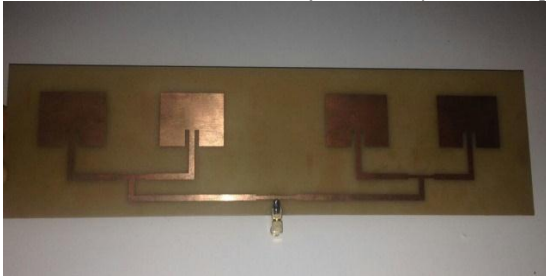


Fig. 15. 4x1 Array Microstrip Antenna Patch

Fig 15, showed result of 4x1 array microstrip antenna using two layers circuit board.

3) Testing with VNA

The 4x1 fabricated microstrip array antenna is able to work at 2.4 GHz with return loss = -19.41 dB, VSWR = 1.235, impedance = 54.77Ω ± 10.750 . This means that the antenna that is fabricated is in accordance with the expected specifications. For its impedance it almost matches the impedance of the RG58 50 Ω coaxial cable.

Bandwidth of 90 MHz between the frequency of 2.328 GHz - 2.418 GHz. Test results with VNA are shown in the following Fig 16-18.

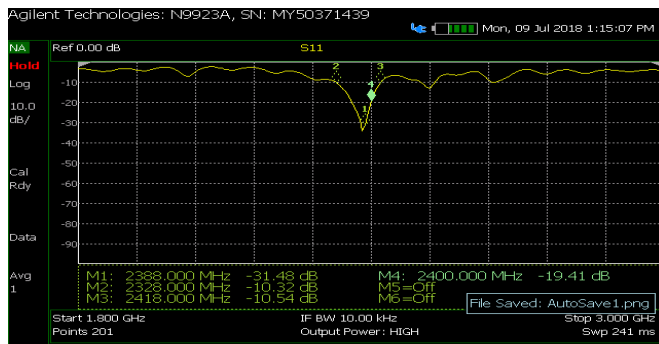


Fig. 16. . Results of Return Loss Testing with VNA in 4x1 Array Microstrip Antenna

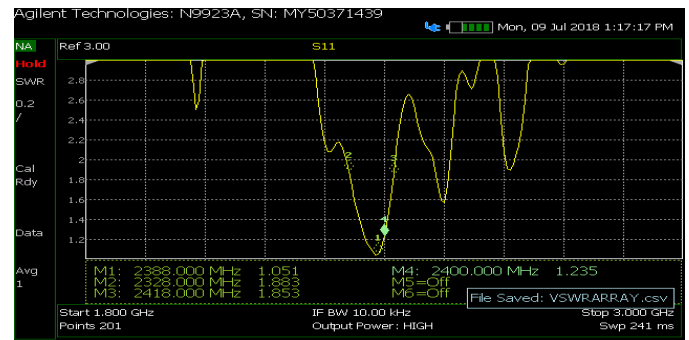


Fig. 17. Results of VSWR Testing with VNA in 4x1 Array Microstrip Antenna

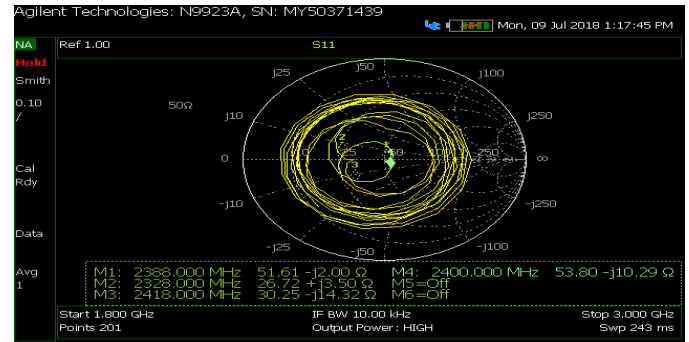


Fig. 18. Results of Impedance Testing with VNA in 4x1 Array Microstrip Antenna

V. CONCLUSION

This research obtained to designed, simulation, fabrication, antenna parameter testing using VNA (Vector Network Analyzer). The conclusions that can be taken from this research are:

1. From simulation showed the sending microstrip antenna that is manufactured according to the expected specifications. the antenna is able to work at a frequency of 2.4 GHz with return loss = -12.06 db, VSWR = 1.692, impedance = 38.35 ohms. It is as desired that antenna work at 2,4 GHz frequency.
2. Design of 4x1 array microstrip antenna fabricated is also in accordance with the expected specifications. From simulation showed that antenna is able to work well at a frequency of 2.4 GHz with return loss = -19.41 db, VSWR = 1.235, impedance = 54.77 ohms.
3. Data communication testing in sending and receiving data has been successfully carried out on both antennas that have the same frequency of 2.4 GHz, where as sender was microstrip antenna and 4x1 array microstrip as received antenna.

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Application of PLS and TRIZ Method in Optimizing Customer Satisfaction Insurance of PT X

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Abstract— Partial Least Square is a more flexible SEM (Structural Equation Modelling) method because it does not assume normally distributed data such as CB-SEM. PLS can also be applied to reflective and formative models with smaller sample quantities. In this study, PLS serves as a predictor to look for variable quality of insurance services including tangible, competency, corporate image, personalized financial planning, technology and assurance that significantly influence customer satisfaction PT X. Research shows only significant assurance dimension and positive effect on customer satisfaction, while for assurance indicator is all significant value which is only 1st assurance indicator is not used because of multicollinearity. After further analysis, satisfaction scores for the four assurance indicators there is a variation between satisfied and very satisfied and the average satisfaction score itself. Unequal customer satisfaction is a problem for the company because it is used the TRIZ (Theory of Invention Problem Solving) method, a method of solving the problem to achieve the best solution with the aim of increasing customer satisfaction from the indicator that has been proven significant according to PLS method. Through the matrix of contradiction between improving feature and worsening feature, the result of the 28th and 1st inventive principles is the selection of the same solution in the form of automatic call center making to optimize the satisfaction of AS2, AS3, AS4, and AS5.

Keywords— PLS; Insurance; PT X; TRIZ

I. INTRODUCTION

People are increasingly aware of the importance of safety needs [1]. It is known from the average per capita expenditure per month for tax utilization and insurance premium in East Java which shows an increase. But ironically, the growth rate of insurance in Bangkalan City is inversely proportional to the decline in insurance growth and the lowest compared to other districts in Madura Island even insurance growth value in Bangkalan below the average growth of insurance in East Java. In addition, the insurance sector in Bangkalan is the sector with the lowest growth rate compared to other sectors. Nevertheless, there is still hope to increase the growth of the sector because although the least decrease in insurance growth in Bangkalan is positive. The selection of insurance PT X as the object of this study is due to the data of top ten market leader insurance companies in Indonesia, PT X has a lower share than other insurers and PT X in Bangkalan Branch itself there is a

decrease in premium holders or customers from 2016 to 2017 now so it must be done a research.

The existence of this problem encourages researchers to conduct research that can improve customer satisfaction so that the growth rate of insurance in Bangkalan can increase from the previous year in the future. The method used in this research is Partial Least Square (PLS) and Theory of Invention Problem Solving (TRIZ). PLS is used to select the dimensions of service quality and produce dimensions that significantly affect customer satisfaction. While, TRIZ will make improvements to the problems that arise in its dimension.

II. LITERATURE REVIEW

A. Insurance

Insurance is an engagement between two parties namely the insurer (insurance company) and the insured (customer) where the insurer is required to provide compensation to the insured in the form of money in the event of a disaster guaranteed by the policy agreed by both parties. This compensation is a reciprocal or fee of a risk transfer in the form of premiums paid by the customer or the underwritten to the insurer.

1) *Life Insurance*: Life insurance is coverage with the object of an insured person and insured is the life of a person. Except for life insurance, guarantees can be extended with health and accidents. This insurance provides assurance of protection in the form of financial risk transfer of a person's death or loss of income opportunities in old age or for family financing. Life insurance is different from general insurance, this type of insurance provides a guarantee for loss of non-life property.

2) *Dimensions of Life Insurance Servqual*

a) *Tangibles*: All indicators or components included in this dimension relate to the provision of facilities and physical communication materials.

b) *Competence*: This component talks about the components of service providers to perform services in a dependent and efficient manner and also about their willingness to provide hassle-free and fast services.

c) *Corporate Image*: This component is concerned with creating an overall image of insurance company organizations in the eyes of customers.

d) *Technology*: All components included in this dimension are related to the use of modern tools (technology) in the provision of services that facilitate customer service.

e) *Personalized Financial Planning*: All the variables contained in this dimension illustrate the handling of preference changes by providing flexible solutions and convertibility options as well as the provision of personal services.

f) *Assurance*: All variables in this dimension assure the policyholder with the knowledge of the agent and the agency's ability to inspire confidence and belief.

3) *Satisfaction*: Satisfaction is the perception of the customer that his expectation of the product or service consumed or used has been fulfilled. There are numerous expert ideas about the dimensions of satisfaction, which can be summarized into the following sections.

4) *Partial Least Square (PLS)*: PLS is one multivariate statistical technique that performs modeling between the dependent variable and independent variable multiple. This method is a variance-based SEM approach that can simultaneously examine the measurement and structural models. The fundamental difference between PLS and SEM is that SEM is confirmatory so that it functions to confirm the theory of previous research that there is a strong theoretical foundation, while the PLS although mainly for exploratory research can also confirmatory research and not necessarily based on strong theory, requires assumption of data normality and can be identified which variable acts as the main determinant.

B. TRIZ

TRIZ [2] stands for Russian Teoriya Resheniya Izobreatatelskikh Zadatch. This method was developed by G.S. Altshuller and his colleagues from the Soviet Union. How TRIZ work is finding a problem before resolving the issue. What is indicated by finding a problem is to evaluate the initial solution to overcome the problem until found the best solution that takes into account the risks and impacts to find the final solution that can really fix the problem.

III. RESEARCH METHODS

A. Research Variables

The research variables consist of the independent variable (Exogenous) and the dependent variable (Endogen). The independent variables in this study are the dimensions of life insurance servqual including tangibles (TA), competence (CO), corporate image (CI), technology (TE), personalized financial planning (PF) and assurance (AS). Here are the code and reference source for each service quality indicator that will be requested to the respondent through the questionnaire.

Dependent variable (Endogenous), Endogen variable in this research is customer satisfaction.

B. Place of Research

The research was conducted by filling out the questionnaire online by using google form feature after the customer contacted via social media that is Whatsapp or second alternative is to visit the customer's address which is in PT X Bangkalan Branch, the area based on the list of addresses that have been obtained by researchers from and on permission the PT X Bangkalan.

C. Model Outline

It is apprehended that six dimensions of life insurance servqual which includes assurance, tangible, personalized financial planning, competence, corporate image, and technology have a significant direct positive effect on customer satisfaction. The measurement model used in this study is a reflective measurement model that each indicator or observative variable is the cause of any latent variables described in the framework of this model. The framework of this model was adopted from Siddiqui's research, 2010 with the difference in this study lies in the use of latent variables of unsatisfied customer satisfaction.

D. Hypothesis

Hypothesis testing is done by Bootstrap resampling method with the minimum bootstrap count of 1000. The hypothesis used is as follows.

The hypothesis for an outer model is:

H0: $\lambda_i = 0$ (to-i indicator is insignificant)

H1: $\lambda_i \neq 0$ (to-i indicator is not insignificant)

The statistical hypothesis for an inner model is:

H0: $\gamma_i = 0$ (the exogenous variable to-i is not significant)

H1: $\gamma_i \neq 0$ (the exogenous variable to-i is significant)

Statistics test: t-test; p-value ≤ 0.05 (alpha 5%); significant. Outer model is significant: the indicator is valid. Inner model is significant: there is significant influence.

E. Settlement Method (Validity and reliability questionnaire)

If $r_{\text{count}} > 0.6$ then the questionnaire tested is valid. If there is an invalid statement item, then the improvements made is to improve the language statement that is more communicative and easier to understand respondents.

While for reliability test is useful to show the consistency level measurement result of a measuring instrument in research, where measuring instrument in this research is item statement in the questionnaire. If $r_{\text{count}} > 0.6$ then the questionnaire tested is reliable.

1) *PLS Test*: Here is the result of the partial least square test (PLS).

TABLE I. EVALUATION REQUIREMENTS OF PARAMETER MODELS

Criteria	Requirement
R-Square	0.67, 0.33, and 0.19 = Strong model, Moderate, and Weak
	0.75, 0.5, and 0.25 = Strong model, Moderate, and Weak
Effect Size f^2	0.02, 0.15, and 0.35 = Small, Medium, and Large
Q^2 Predictive Relevance	$Q^2 > 0$ model has predictive relevance
Significant (two-tailed)	T-Value 1.65 (sig. 0.1), 1.96 (Sig. 0.05), and 2.58 (Sig. 0.01)

TABLE II. TERMS OF EVALUATION OF STRUCTURAL MODELS

Validity and Reliability	Parameter	Requirement
Convergent Validity	Loading Factor	> 0.70
	Average Variant Extracted	> 0.50
Discriminant Validity	Cross Loading	> 0.70
	Root Square AVE and correlation between laten construct	Root Square AVE > correlation between laten construct
Realibility	Cronbach Alpha	> 0.70
	Composite realibility	> 0.70

The GoF Index analyzes to evaluate measurement models and structural models as well as simple measurements for the whole of the model predictions.

$$GoF = \sqrt{Com \times R^2} \quad (1)$$

Com is known as the average communality index and R^2 is the average R squares. The recommended communal value is 0.5 and R^2 is 0.02 = small, 0.13 = medium and 0.26 = large. So, the resulting GoF value is 0.1 = small, 0.25 = medium and 0.36 = large.

2) *TRIZ Method*: In the TRIZ method, contradictory analysis consists of improving feature and worsening feature analysis.

Improving features is an evaluation of the initial solution by making possible positive impacts if the initial solution is applied to the service system. The vertical direction in the matrix contradiction.

Worsening feature is an evaluation of the initial solution by raising the risks or obstacles that may arise and must be overcome if you want to realize the initial solution. The direction is horizontal in the contradiction matrix.

The next step is to look for the inventive principles of meeting the parameters of improving feature and worsening feature techniques in contradiction matrices. Inventive principles are alternative solutions presented by TRIZ.

IV. DISCUSSION

A. Validity and Reliability Test

Test of validity and reliability of the questionnaire on pre-sampling was done by distributing questionnaires to 30

respondents. The result of the validity test shows that all questionnaire indicators have sig (2-tailed) under 0.05 or Pearson value above r-table so the statement in the questionnaire is valid. While the results of the reliability test showed a score of 0.754 from the number of respondents as many as 30 people. This value is above 0.6 so the statement in the questionnaire is stated to be reliable.

B. Profile of Respondents

All respondents feel satisfied with the quality of service and satisfaction aspects provided by PT X insurance which can be seen from the average score per indicator that mostly has an average value of 2.5-3.25.

C. Test Measurement Outer Model (Measurement Model)

1) *Convergent Validity*: Here is the output of convergent. The indicator is reliable if it meets a score of at least 0.5 in scale-up research on social studies using a questionnaire. Fig. 1 below describes Outer loading PF3.

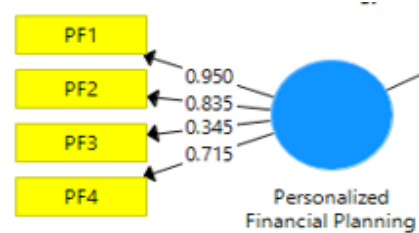


Fig. 1. Outer loading PF3

It is known that the value of outer loading PF3 with its own construct (Personalized Financial Planning) is 0.345. This value is below the specified requirement of 0.5 so that the PF3 indicator must be eliminated so as not to affect the outcome.

2) *Discriminant Validity*: Cross loading value of CI1 and CI5 on the construct of corporate image and PU2 to the customer satisfaction construct are not greater than the cross loading value between CI1 to tangible, and CI5 and PU2 to the assurance construct so it is inferred not to meet the requirements of cross loading and the indicator must be eliminated from the path diagram in the PLS visual model. However, this elimination is done after looking at the p-value to see the significance of the indicator which should be below 0.05 and the effect of the existence of the indicator on the result of R^2 .

Discriminant validity can also be observed by comparing the AVE square root value with the correlation value between constructs (Fornell Larcker Criterium Test). The results are answered if the AVE square root is greater than the correlation value of a construct to another construct. As is comprehended the square root of AVE is the value of the correlation between the construct and the construct itself, so ideally the construct correlation for the construct with the construct itself must be the greatest compared to the other constructs.

It is known that the highest value of construct correlation is on the corporate image construct and customer satisfaction not on the construct itself but on another construct that is assurance. This correlation value also has a value below the AVE square root so it is not eligible and can be eliminated if it has a p-value below 0.05.

D. Construct Reliability and Validity

TABLE III. RELIABILITY AND VALIDITY EACH INDICATOR

Indicator	Composite Reliability	Cronbach's Alpha	Alpha
Assurance	0.848	0.758	0.587
Competency	0.869	0.798	0.626
Corporate Image	0.847	0.751	0.589
Customer Satisfaction	0.858	0.789	0.552
Personalized Financial Planning	0.877	0.785	0.706
Tangible	0.853	0.741	0.663
Technology	0.908	0.848	0.768

Based on Table III it is known that the value of composite reliability, Cronbach's alpha and AVE for all indicators are eligible.

E. Structural Model Inner Model (Structural Model)

1) *P-value or T-value*: To know the level of influence or significance of the indicator with the construct and between exogenous constructs with endogenous constructs. Viewed from p-value then the value must be $p\text{-value} \leq \text{sig.}$ Because the level of significance used is 0.05 then the value of p-value must be $p\text{-value} < 0,05$.

There are some indicators that are not valid on some criteria, but according to the significance test, all the indicators are able to explain well each construct because of the $p\text{-value} \leq \text{sig.}$ However, since the presence of PF3 and CI1 in the model makes the coefficient of determination of customer satisfaction (R^2) as a low endogenous construct which is known to researchers after trial and error, it is finally concluded that only PF3 and CI1 indicators are dropped from the initial model.

2) R^2 : The coefficient of determination or value that states how large a collection of exogenous constructs can affect customer satisfaction (endogenous constructs). The value obtained in the initial model is 0.749 which is included in the strong category [3].

3) f^2 initial model: The effect size of the endogenous latent variable to the exogenous latent variable of 0,501 for assurance. The f^2 value is strong. But the significance value $> 0,05$ so it is invalid.

4) Q^2 model start: Test of the kindness of structural model can be seen from the value of Q^2 . This value is calculated from the value of R^2 with the mathematical formula and does not come out in the form of smart PLS software output.

$$Q^2 = 1 - (1 - R^2) \quad (2)$$

$$Q^2 = 1 - (1 - 0.749) = 1 - 0.251 = 0.749$$

Then $Q^2 = R^2$. Since $Q^2 > 0$ means the model has predictive relevance

5) *The initial Path Coefficient model*: The value of the latent variable coefficient of assurance towards customer satisfaction is 70,4% which means strong and also positive, it implies that increasing assurance aspect is getting bigger and also customer satisfaction. While for competency, personalized financial planning and technology have positive influence but not significant. For corporate image and tangible have a negative but not significant influence.

Here is the output of smart PLS which is the final model has eliminated the indicator that is considered not qualified PLS.

TABLE IV. COMPARISON OF START AND END MODELS

		Initial Model	Final Model	Information
R^2	Customer Satisfaction	0.749	0.755	Strong model
P-value for Path Coefficient	AS2 > Assurance	0.013	0.012	Significant
	AS2 > Assurance	0.000	0.000	Significant
	AS2 > Assurance	0.000	0.000	Significant
	AS2 > Assurance	0.001	0.000	Significant
	Assurance > Customer satisfaction	0.007	0.006	Significant
Path Coefficient	Assurance > Customer satisfaction	0.681	0.704	Strong influence
f^2	Assurance	0.501	0.508	Strong effect size
P-value for f^2	Assurance	0.404	0.332	Not Significant

$$GoF = \sqrt{0.641 \times 0.755} = \sqrt{0.484} = 0.696$$

The criteria for GoF values are 0.1 for GoF small, 0.25 for medium GoF and 0.36 for large GoF. Since the GoF value for the model is 0.696 then the overall model prediction is declared good.

F. Hypothesis testing

For assurance aspect, $p\text{-value} 0,002 < 0,05$ So Accept H_0 which means there is the significant relation of assurance with customer satisfaction. Fig. 2 below shows PLS and Path Coefficient model.

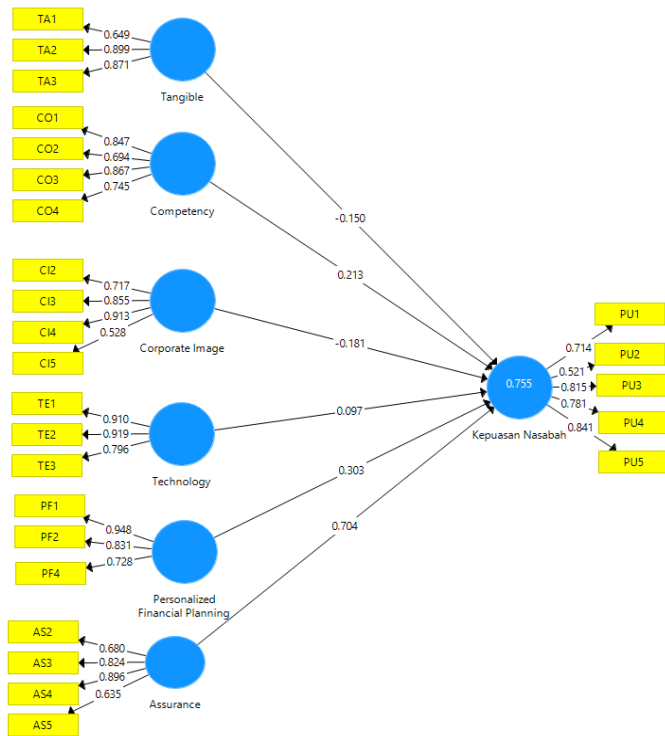


Fig. 2. PLS and Path Coefficient model

G. TRIZ Method

TABLE V. INVENTIVE PRINCIPLES INDICATORS

Improving Feature	Parameter Service	Worsening Feature	Parameter Service	Inventive Principle	Chosen
Quick response with the wishes of potential customers	#Productivity (39)	Should be followed by improvement of information services	#Equipment complexity (36)	12, 17, 28, 24	#28
Agent ability creates a familiar atmosphere	#adaptability (35)	Agents must be trained	#Power (21)	19, 1, 29	#1
Agent do research to find more applicable forms of information	#Measurement accurate (28)	Employee break time	#Loss of time (25)	24, 34, 28, 32	#28
Agents provide the totally of services by providing flexibility to schedule premium payments	#Style	Customers flexibility provided by the agent	#Weight of moving object (1)	8, 1, 37, 18	#1

The same number of indicators is the 28th inventive principles for AS2 and AS4 and the 1st inventive principles for AS3 and AS5. So these two inventive principles that will be generated by researchers to get the best solution. The selection

of the same inventive principles is based on the opinion of Savransky [4] that occurs at least twice because in order to focus on the quality improvement that will be done.

Final solutions for AS2 and AS4 [5] are (1) making FAQs (Frequently Asked Questions) or serialized video explanations about PT X and other insurances that customers often ask in traditional service (2) making an auto center that automatically answers customer questions without cost, (3) creation of community forum for insurance customers (clearer structure, with real-time communication) through social media WhatsApp and occasional gathering.

While the final solution for AS3 is (1) prioritize customers who have high loyalty seen from the existence of repurchase by eliminating other insurance products that are quiet enthusiasts or interested customers who are not loyal. (2) The division of the agent's task becomes simpler, ie for product information can be through calling the automated call center system and also (3) the customer can choose the agent as he wishes to pay the claim or explain the less obvious policy.

The solution for the four selected indicators is the creation of an automated call center. This selection is based on the solution equations on AS2, AS3, AS4 and AS5 indicators.

V. CONCLUSION

- Variable quality of insurance services include tangible, competency, corporate image, personalized financial planning, technology, and assurance only one variable that is assurance that significantly affects the satisfaction of PT X Bangkalan insurance customers with the p-value of 0.002.
- The average AS2, AS3, AS4 and AS5 satisfaction scores are in the 3rd range with the answer variations dominated between 3 and 4. Due to the problem of service quality perceptions, the TRIZ method will create a solution to increase the average score of satisfaction customers to be very satisfied The end result of TRIZ is the application of 28th inventive principles for increasing satisfaction in AS2 and AS4 indicators, while for AS3 and AS5, the inventive principles used are 1st inventive principles.
- Priority solutions to optimize customer satisfaction on AS2, AS3, AS4 and AS5 indicators is by making the automatic call center.

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Development of Hot Press Molding for HDPE Recycling and Process Characterization

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Abstract— The 2nd generation HDPE Recycle Hot Press machine is the revamps of the first generation machine. The first generation hot press still has many shortcomings that make production results not optimal, such as porosity defects, limited product dimensions and the manual pressing process. The method used for the 2nd Generation HDPE Hot Press Recycle characterization is RAL23. Factors that have a significant effect on porosity defect are heating temperature factor. Combination of treatments that yield the smallest average porosity defect is 180°C heating temperatur, 3 minute holding time, and opening mold at temperatur 100°C, average porosity defect reached 0 mm². Factors that have a significant effect on flashing defect are factors heating temperatur, holding time, opening mold temperature. Combinations factor that yield the smallest average flashing defect is a combination of 150°C heating temperatur, 6 minute holding time, and opening mold at 85°C, with an average flashing defect of 12.09 g. Factors that have a significant effect on energy consumption are factors heating temperatur and the interaction of factor holding time. Treatment combinations that yield the smallest average energy consumption that is a combination of 150°C heating temperatur, 6 minute holding time, and opening mold at 85°C with average energy consumption of 0.4233 kwh.

Keywords—Hot Press Machine; HDPE; Porosity; Flashing

I. INTRODUCTION

Plastic waste processing technology is increasingly sophisticated. There are many innovations and the development of plastic waste treatment processes, ranging from extrusion processes, blow molding, injection, coating, and compression[1, 2, 3]. However, the development of plastic waste processing technology has not been able to suppress the high level of plastic waste that has increased every year. One of them is the type of plastic HDPE (High Density Polyethylene) which is one type of plastic that is often found in everyday life[4, 5].

Plastics HDPE types that are often found in everyday life include the cap of mineral water, the oil packaging, household appliances and so on. Characteristics of HDPE plastic that are harder, stronger and more resistant to high temperatures make this type of plastic has its own advantages for recycling[5, 6, 7]. In addition the price of HDPE plastic scrap ranges between Rp. 5000 to Rp. 8000 per kilogram is still relatively cheap and

easy to find[8]. If HDPE plastic waste treatment can be done well, it will provide considerable benefits.

The second generation HDPE Recycle Hot Press machine is the revamp of the first generation of Hot Press Recycle Plastic machine. In general, the working systems of both machine have no significant differences. The development that was carried out was replacing the mechanical jack with pneumatic piston. Then the mold dimensions were originally only 20 cm x 10 cm, revamp to 50 cm x 30 cm. In addition, the 2nd Generation HDPE Recycle Press tool is designed with high flexibility so that it is user friendly and easy maintenance

Plastic waste processing technology is an innovation to overcome the increasing plastic waste in the world. The technology used has also varied, ranging from work concepts and processing techniques. There are several ways of processing plastic waste, namely extrusion, blow molding, injection molding, compression molding, melt flow index and film maufacturer.

1. Extrusion Molding

The working principle of plastic waste processing by extrusion is by inserting liquid or solid plastic material continuously. But most are solid plastic that has been chopped or destroyed. The material included can be in the form of pellet powder, splinters or logs[9]. Extrusion machines use the concept of combining a single rotating screw in a horizontal horizontal cylindrical steel pipe[10, 11]. The rotating skurp will push the molten plastic material by the cylindrical pipe to the end of the nozzle as a place for the molten plastic to exit [12].

2. Blow Molding

Blow molding is a process of plastic processing that produces hollow objects in the final product. Examples are mineral water bottles, cooking oil bottles and so on. There are three ways of processing platinum by blow molding, namely extrusion blow molding, injection blow molding and stretch blow molding [13].

3. Injection Molding

In the injection process there are two ways and types of machines used are vertical injection machines and horizontal injection machines. The working principle of injection

machines is almost the same as extrusion. First, the plastic collected in the hopper enters the cylindrical pipe that has been heated by the heating element. Inside the plastic cylinder pipe is melted by a heater that has been installed. Plastic seeds that have been melted are then injected until they come out through the nozzle into the desired mold [14, 15].

4. Compression Molding

The basic process of processing by using this method is heating the plastic material in the mold and then being pressurized to form the desired mold. Plastic material that melts due to the heat element will fill the cavity in the mold so that it will be solid. After the pressure has been maximal and the plastic material has melted, then cool the mold until the plastic material really hardens and forms the desired mold [16, 17, 18].

II. OBJECTIVE AND RESEARCH METHOD

The aims of this study is to improve the desain quality of hot press machines and characterize the newly build machines. This study uses the dependent variable and independent variables.

a. Independent Variable

The independent variables of this study are:

1. Heating temperature

Variable heating temperature used is 150°C and 180°C. Level determination of 150°C and 180 °C based on previous research and also melting point of HDPE plastic itself.

2. holding time

Holding time is the time it hold at the specified temperature. In this study, it took 3 minutes and 6 minutes.

3. Opening mold temperature

When opening the mold the specified temperature is 85°C and 100°C.

b. Dependent variable

The dependent variable in this study is:

1. Porosity defects

2. Flashing defect

3. Energy consumption

III. RESULT AND DISCUSSION

The results of the study are presented in Tables I, III, V. Table I shows the results of porosity defect characterization on engine parameter settings. Table III shows the results of the characterization of the flashing defects against the engine parameter settings. Table V shows the results of the characterization of energy consumption on the engine parameter settings.

Based on table II the analysis of variants for porosity defects, can be made a decision:

a. Factor a (Heating Temperature)

P-value is 0.004 5 0.05, so reject H0. There is a significant effect of heating temperature on porosity defects

b. Factor b (Heating Time)

The value of P-Value is 0.457> 0.05 so accept H0. There is no significant effect of heating time on porosity defects

c. C factor (opening temperature)

Value of P - Value 0.284> 0.05 so accept H0. There is no significant effect of the opening temperature on porosity defects

d. Combination of a factor and factor b

The P-value is 0.785> 0.05 so accept H0. There is no significant effect of heating temperature and heating time on porosity defects

e. Combination of factors a and c

P-value value = 0.256> 0.05 so accept H0. There is no significant effect of heating time and opening temperature on porosity defects

f. Combination of factors b and c

Value of P-value = 0.785> 0.05 so accept H0. There is no significant effect of heating time and opening temperature on porosity defects

g. A combination of factors a, b and c

The value of P-value = 0.734> 0.05 so accept H0. There is no significant effect of heating temperature, heating time and opening temperature on porosity defects

Based on table IV, analysis of variants for flashing defect, can be made a decision:

a. Factor a (Heating Temperature)

The value of P-value is 0.000 Sehingga 0.05, so reject H0. There is a significant effect of heating temperature on flashing defect

b. Factor b (Heating Time)

Value of P-Value 0,000 ≤ 0.05 so reject H0. There is a significant effect of heating time on flashing defect

c. C factor (opening temperature)

The value of P-Value is 0.040 lak 0.05 so it rejects H0. There is a significant effect of the opening temperature on flashing defect

d. Combination of a factor and factor b

P-value is 0.390> 0.05 so accept H0. There is no significant effect of heating temperature and heating time on flashing defect

e. Combination of factors a and c

P-value value = 0.179> 0.05 so accept H0. There is no significant effect of heating time and opening temperature on flashing defect

f. Combination of factors b and c

P-value value = $0.462 > 0.05$ so accept H_0 . There is no significant effect of heating time and opening temperature on flashing defect

g. A combination of factors a, b and c

The value of P-value = $0.333 > 0.05$ so accept H_0 . There is no significant effect of heating temperature, heating time and opening temperature on flashing defect

Based on table VI, the analysis of variants for energy consumption can be made a decision:

a. Factor a (Heating Temperature)

The value of P-value is 0.000 Sehingga 0.05, so reject H_0 . There is a significant effect of heating temperature on energy consumption

b. Factor b (Heating Time)

Value of P-Value $0.099 > 0.05$ so accept H_0 . There is no significant effect of heating time on energy consumption

c. C factor (opening temperature)

P-Value value of $0.0568 > 0.05$ so that it accepts H_0 . There is no significant effect of the opening temperature on energy consumption

d. Combination of a factor and factor b

The P-value is $0.322 > 0.05$ so accept H_0 . There is no significant effect of heating temperature and heating time on energy consumption

e. Combination of factors a and c

P-value value = $0.208 > 0.05$ so accept H_0 . There is no significant effect of heating time and opening temperature on energy consumption

f. Combination of factors b and c

P-value = $0.000 \leq 0.05$ so reject H_0 . There is a significant effect of heating time and opening temperature on energy consumption

g. A combination of factors a, b and c

P-value value = $1 > 0.05$ so accept H_0 . There is no significant effect of heating temperature, heating time and opening temperature on energy consumption

TABLE I. DATA TABULATION FOR POROSITY DEFECT

Flashing Defects				
heating temperature (°C)	heating time (minute)			
	3		6	
	opening temperature			
	85	100	85	100
150	11	13	2	6
	17	0	28	6
	4	3	9	11
180	0	0	0	4
	3	0	3	4
	1	0	0	0

TABLE II. ANALYSIS OF VARIANCE FOR POROSITY DEFECT

Source	Df	Adj SS	Adj MS	F-value	P-value
Factor a	1	384.00	384.00	11.05	0.004
Factor b	1	20.17	20.167	0.58	0.457
Factor c	1	42.67	42.667	1.23	0.284
Factor a * Factor b	1	2.67	2.667	0.08	0.785
Factor a * Factor c	1	48.17	48.167	1.39	0.256
Factor b * Factor c	1	2.67	2.667	0.08	0.785
Factor a * Factor b * Factor c	1	4.17	4.167	0.12	0.734
Error	16	5556.00	34.75		

TABLE III. DATA TABULATION FOR FLASHING DEFECT

Flashing Defects				
heating temperature (°C)	heating time (minute)			
	3		6	
	opening temperature			
	85	100	85	100
150	21.460	20.435	12.602	14.460
	17.417	44.985	10.349	15.532
	12.357	29.911	13.341	21.737
180	37.809	53.892	30.458	41.026
	56.039	44.971	37.551	35.793
	48.592	48.360	28.697	28.681

TABLE IV. ANALYSIS OF VARIANCE FOR FLASHING DEFECT

Source	Df	Adj SS	Adj MS	F-value	P-value
Factor a	1	2758.11	2758.11	61.87	0.000
Factor b	1	888.18	888.18	19.93	0.000
Factor c	1	222.72	222.72	5.00	0.040
Factor a * Factor b	1	34.83	34.83	0.78	0.390
Factor a * Factor c	1	88.00	88.00	1.97	0.179
Factor b * Factor c	1	25.32	25.32	0.57	0.462
Factor a * Factor b * Factor c	1	44.47	44.47	1.00	0.333
Error	16	4774.83			

TABLE V. DATA TABULATION FOR ENERGY CONSUMPTION

Flashing Defects				
heating temperature (°C)	heating time (minute)			
	3		6	
	opening temperature			
	85	100	85	100
150	0.60	0.47	0.50	0.52
	0.56	0.44	0.42	0.55
	0.69	0.52	0.45	0.57
180	0.69	0.61	0.63	0.70
	0.73	0.61	0.59	0.71
	0.72	0.59	0.59	0.68

TABLE VI. ANALYSIS OF VARIANCE FOR ENERGY CONSUMPTION

Source	Df	Adj SS	Adj MS	F-value	P-value
Factor a	1	0.141076	0.141076	180.09	0.000
Factor b	1	0.002400	0.002400	3.06	0.099
Factor c	1	0.000267	0.000267	0.34	0.568
Factor a * Factor b	1	0.000817	0.000817	1.04	0.322
Factor a * Factor c	1	0.001350	0.001350	1.72	0.208
Factor b * Factor c	1	0.062017	0.062017	79.17	0.000
Factor a * Factor b * Factor c	1	0.000000	0.000000	0.000000	1.000
Error	16	0.012533	0.000783		

IV. CONCLUSION

Factors that have a significant effect on porosity defects are factor a (heating temperature). While the combination treatment that produces the smallest average porosity defect is a combination of 180 3 100 means using a heating temperature of 180°C, heating time of 3 minutes and an opening mold at temperature 100°C with an average porosity defect of 0 mm². In addition, all combinations of porosity defect testing are not significantly different.

Factors that have a significant effect on flashing defect are factors a (heating temperature), b (heating time), and c (opening temperature). While the combination treatment that produces the smallest average flashing defect is a combination of 150°C heating temperature 6 minutes heating time and opening mold at temperatur 85°C, combination 150°C heating temperature, 6 minutes heating time 100°C opening temperature and combination 150°C heating temperature 3 minutes heating time 85°C opening temperature with the smallest average flashing defect 12.0973 g.

Factors that have a significant effect on energy consumption are factors a (heating temperature) and the interaction of factor bc (heating time and opening temperature). While the combination treatment that produces the lowest average energy consumption is a combination of 150°C heating temperature 3 minutes heating time and 100°C opening temperature and combination 150°C opening temperature 6 minutes heating time 85°C opening temperature. with the smallest average energy consumption 0.4233 kwh.

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Analysis and Evaluation Service Quality with Fuzzy - Banking Service Quality in East Java, Indonesia

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Abstract— The research aimed at analyzing and evaluating the banking service quality in East Java. The research to know the service standard which is suitable for the customer's desire and arranges an improvement priority of service quality that should be given to the customers. The method used to measure quality is Fuzzy-Banking Service Quality. Service quality analysis by using fuzzy Banking Service Quality which is aided by using the MATLAB application. Based on the research results, customers valuation average toward the bank customer level is good. The services given have fulfilled the customer expectation. There is service which becomes the priority to be improved that is e-channel, e-Banking, sms banking and ATM, competitive interest and parking lot for customers.

Keywords—fuzzy-banking service quality; e-channel; e-banking; sms banking

I. INTRODUCTION

Banking is service based on trust and gives emphasis to the service quality [1]. The service quality is an important factor in determining the success of banking [2]. The phenomenon occurred in almost all banks, the customers need maximum services continuously. Service quality gives encourage to the customers, to make a strong bond with the bank [3]. In long term make possible the bank to understand the customer's satisfaction and customers needs. Bank able to improve the customer's satisfaction by maximizing the please customers experience, and minimizing less please experiences. Service quality becomes the expected advantage level and control for the advantage to fulfill the consumer's needs [4]. Service quality becomes the main component for the bank products. The competition will be influenced by the bank ability to give best services compared to the competitor [5]. The dimension of service quality is the picture for the how far the differences between perceived service, with expected service for the services received by the customers. The discrepancy between perceived service to expected services creates service quality problem called GAP [6].

Service quality measurement usually used to measure the quality of a conventional bank and the mostly used is

SERVQUAL. SERVQUAL based on "Gap Model" developed by Parasuraman, et al. [7]. SERVQUAL based on five quality dimensions, tangibles, reliability, responsiveness, assurance, and empathy [8]. Service quality becomes worse caused by (a). not skilled in servicing consumers b. the dress does not fit c. impolite speech or cause resentment d. disturbing body odor e. always sullen [9]. Factors that should be considered in improving the service quality is a. identifying the main determinant of service quality and estimate the given valuation by the target market b. manage the customer's expectation by promising the services can be promised c. strengthen the customer's perception during and after services given d. develop a quality culture that produces conducive environment and quality perfection continuously [10]. Quality culture consists of philosophy, belief, attitude, norm, value, tradition, procedure, and expectation [11].

Development of then the banking service quality concept is Banking Service Quality (BSQ) [12]. BSQ has higher validity and reliability level compared to SERVQUAL. [13]. BSQ consists of six dimensions: (1) Effectiveness and Assurance is combination of competence and good response level from employee and security factor (2) Access is customers perception toward modern equipment and important element that guarantee the easy access for transaction (3) Price is factor that relates directly to the cost charged (4) Tangible refer to atmosphere, service equipment, and service appearance. (5) Service Portfolio, refer to complete service and consistent service follow the banking world development 6. Reliability is formed from two indicators, that is good archiving and no mistake in process of service delivery [12].

The research aimed at analyzing and evaluating the banking service quality in East Java. The research can be used as consideration to improve the service quality in East Java. Banking service quality is any services delivery maximum given by the bank. Service quality is a statement about attitude, and relationship produced from the comparison between expectation and performance. The research focus on banking service, that is BSQ and Fuzzy method. The fuzzy method is used to prevent uncertain individual viewpoint toward perception and expectation desired [14]. Fuzzy - Banking Service Quality is a fuzzy set theory which gives means to

represent uncertainty and a tool for modeling the uncertainty that relates with the fuzziness, uncertainty and lack of information about a certain element from the problem faced [15].

II. METHOD

The research was done at one of the banks in East Java. The research is also survey research, which is part of descriptive research, research done to obtain facts from the existing symptoms and find a factual explanation to get the truth. Data collected from the population by using questionnaires as the data collecting tools. The population of the research is the Mandiri Bank customers of East Java of 6155 customers. A sample of the research was determined by a slovin formula of 99 persons [16]. The instrument used in the research is a questionnaire. Open questionnaires were used to know the customer's desires about banking services. Then will become variable in the research. While closed questionnaires, to know the characteristic interest and the attribute category of the customer services.

Variables which are measured come from Banking Service Quality (BSQ). From the recapitulation of open questionnaires were obtained the attributes of consumers desires. The attributes are the questions in the closed questionnaire to categorize the attributes become closed questionnaires questions to categorize the attributes that become the questionnaires questions items such as (1) regulation easy to understand (2) the requirements not complicated (3) carefulness, efficiency, and service speed (4) guarantee under government umbrella, (5) the presence of *E-channel*, *E-Banking*, sms Banking and ATM, (6) the presence of comfort

Banking Hall, (7) the park lot availability, (8) administrative easiness, (9) competitive interest, (10) loan with low interest. One dimensional category gives the concept that satisfaction linearly connected with the given performance [17]. While for an attribute with the attractive category is the customers need that not depend on the category given by the attribute.

Validity test is done to know the distributed questionnaire accuracy [18]. Attribute is valid if $r_{calculated} > r_{table}$, while data considered as reliable if the Cronbach Alpha $> 0,6$ [19]. At the recapitulation stage, the data processing and analysis, the researcher recapitulate the obtained data from questionnaires, determine the scoring average of perception and expectation, calculate gap, then calculate the BSQ score by calculating the gap average among criteria. Then at the analysis stage, the technique done by using fuzzy logic concept through MATLAB program. Then, implementation and analysis of Fuzzy BSQ with rules arranged by using Matlab Fuzzy Logic ToolBox to know the services quality of Mandiri Bank in East Java.

III. DISCUSSION

A. Banking Service Quality (BSQ)

Based on gaps models of service quality [20], from gap which gave impact to service quality, the gap between the customer's perception and expectation about service quality. If the customer's perception and expectation proved equal and even the perception better then expectation then the bank gets a positive image and impact if the otherwise then will cause problems for the bank [21]. By using data processing at BSQ method, the calculation obtained given in Table 1.

TABLE I. CALCULATION OF BSQ AND GAP

Number	Attributes of BSQ	Average Attribute of BSQ		Gap of BSQ
		Perception	Expectation	
1.	Regulation easy to understand	4	4	0
2.	Requirements not complicated	4	4	0
3.	Carefulness, efficiency and service speed	4	4	0
4.	Guarantee under government umbrella	4	4.5	-0.5
5.	Presence of <i>E-channel</i> , <i>E-Banking</i> , sms Banking and ATM services	4	5	-1
6.	Presence of comfort Banking Hall	4	4.25	-0.25
7.	Availability of parking lot	4	4.67	-0.67
8.	Administrative easiness	5	5	0
9.	Competitive interest	4.25	5	-0.75
10.	Loan with low interest	4	4.5	-0.5
Total		37.25	40.92	-3.67
Average		3.725	4.092	-0.367

Based on Table 1. Stated that calculation of BSQ and gap, can be seen that the biggest gap is attribute "the presence of *E-channel*, *E-Banking*, sms Banking and ATM services" that is -1, means the attribute which according to the customers of Mandiri Bank in East Java, unable to fulfill the service quality which is suitable with customers expectation.

1) Fuzzy Analysis

Fuzzy logic is a decision making process based on rules aimed at problem solving. The system difficult to be modeled or there are ambiguity and vagueness. Many benefits of using fuzzy logic. Fuzzy logic conceptually easy to understand and

has a natural approach. [22]. Steps done at the stages, that is fuzzification, inference, and defuzzification. At the step of langkah fuzzification, there are two input variables, perception and expectation and output variable that is service quality [23]. At input variable, that is perception and expectation given score with 5 parameters that are very important (VI)/ Very Satisfied (VS), Important (I) / Satisfied (S), Important Enough (IE)/ Satisfied Enough (SE), Not Important (NI)/ Not Satisfied (NS), Very Not Important (VNI)/ Very Not Satisfied (STP). While fuzzy interference produces an output of service quality, given score 3 (three) parameter, High (H), Fair (F) and Low (L).

At the inference level, the determination of fuzzy logic rule is determined, the rule made to state the direct relationship between input and output suitable with the obtained data. An operator which is used to relate between two input is AND and which relate between input-output is IF-THEN. Based on the existing data, can be formed 25 rules, as follows:

1. If (Expectation is VNI) and (Perception is VNI) then (Service is R);
2. If (Expectation is NI) and (Perception is I) then (Service is F);
3. If (Expectation is IE) and (Perception is VNI) then (Service is R);
4. If (Expectation is IE) and (Perception is I) then (Service is F);
5. If (Expectation is VI) and (Perception is VI) then (Service is H);
6. If (Expectation is NI) and (Perception is IE) then (Service is R);
7. If (Expectation is IE) and (Perception is NI) then (Service is F);

The last step is (defuzzyfication), with the input of fuzzy set obtained from the fuzzy rule determined before and output produced is number in the fuzzy set itself. So, if given a fuzzy set in a certain range then can be taken the real value as output. The confirmation was done with aid of MATLAB ToolBox Fuzzy. Based on the data, expectation, and perception obtained, the measurement results of the service quality level of Mandiri Bank in East Java used the Fuzzy method, produced values as given in Table 2.

TABLE II. FUZZY SET

Range analysis	The name of the Fuzzy Set	Domain	Range
0-100	Very impotent	[65-100]	65 80 100 100
0-100	Important	[50-80]	50 65 80
0-100	Important Enough	[35-65]	35 50 65
0-100	Not Important	[20-50]	20 35 50
0-100	Very Not Important	[0-35]	0 0 20 35

Membership function diagram for expectation variable as shown in Fig. 1.

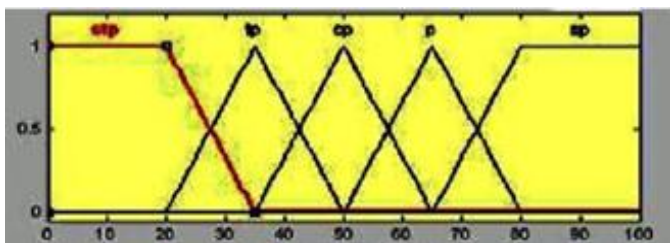


Fig. 1. Membership function diagram for expectation variable

At expectation variable in Table 2, data divided into 5 fuzzy sets, very not important, not important, important enough, important, and very important. The not important fuzzy set has domain [0-35] with the highest membership degree of 1 located at the value of 20. The not important fuzzy set has domain [20-50] with the highest membership degree of

1 located at the value of 35. Important enough fuzzy set has domain [35-65] with the highest membership degree of 1 located at the value of 50. The important fuzzy set has domain [50-80] with the highest membership degree of 1 located at the value of 65. The very important fuzzy set has domain [65-100] with the highest membership degree of 1 located at the value of 80. If the expectation variable value more than 20, then the value closer to not important. The membership function formation for the fuzzy set, that is very not important and not important, as follows.

Membership function for the very not important set can be seen in equation (1).

$$\mu_{STP_{[X_i]}} = \begin{cases} 0; & X_i \geq 35 \\ \frac{(35 - X_i)}{35 - 20}; & 20 \leq X_i \leq 35 \\ 1; & X_i \leq 20 \end{cases} \quad (1)$$

Membership function for the not important set can be seen in equation (2).

$$\mu_{TP_{[X_i]}} = \begin{cases} X_i \leq 20 \text{ atau } X_i \geq 50 \\ \frac{(X_i - 20)}{(35 - 20)}; & 20 \leq X_i \leq 35 \\ \frac{(50 - X_i)}{(50 - 35)}; & 35 \leq X_i \leq 50 \end{cases} \quad (2)$$

At the perception variable, data divided into 5 fuzzy sets, very not satisfied, not satisfied, satisfied enough, satisfies, and very satisfied, with equal representation with the expectation variable. At the service variable, output variable with three tier valuation, low, fair, and high. Variable valuation is obtained from the calculation toward two variable input, that is expectation and perception.

TABLE III. FUZZY SET VARIABLE SERVICE

Range analysis	The name of the Fuzzy Set	Domain	Range
0-100	High	[50-100]	65 80 100 100
0-100	Fair	[20-80]	20 50 80
0-100	Low	[0-50]	0 0 20 50

Membership function diagram for variable service as shown in Fig. 2.

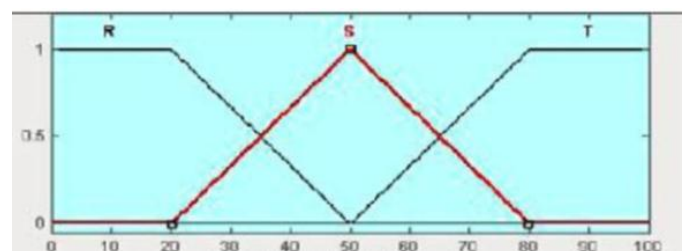


Fig. 2. Membership function diagram for expectation variable

B. Processing of Servqual Fuzzy with Fuzzy Logic ToolBox

Based on data of expectation and perception obtained, from the service quality level measurement of Mandiri Bank in East

Java used the Fuzzy method of BSQ, produced values given in Table 4.

TABLE IV. MEASUREMENT RESULTS OF SERVICE QUALITY LEVEL

Respondents	Average score		Gap	Respondents	Average score		Gap	Respondents	Average score		Gap
	Perc.	Exp.			Perc.	Exp.			Perc.	Exp.	
1.	88	90	88.7	34.	81.3	91.3	82.7	67.	87	94	84
2.	65.4	85.4	81.6	35.	74.7	87.8	79.4	68.	65.4	85.4	81.6
3.	77.6	93.6	80.9	36.	70.4	94.8	81.7	69.	75.4	85.4	84.6
4.	75.4	85.4	84.6	37.	73.6	92.6	84.8	70.	81.8	91.2	83.2
5.	81.8	91.2	83.2	38.	84.7	92.4	85.7	71.	84.2	92.2	83.4
6.	84.2	92.2	83.4	39.	90.4	95.4	92	72.	74.7	94.7	89.7
7.	74.7	94.7	89.7	40.	87	94	84	73.	88.2	90	88.8
8.	88.2	90	88.8	41.	65.4	85.4	81.6	74.	87.6	97.6	94.5
9.	87.6	97.6	94.5	42.	74.7	87.8	79.4	75.	85.3	95.4	87.6
10.	85.3	95.4	87.6	43.	70.4	94.8	81.7	76.	74.7	87.8	79.4
11.	74.7	87.8	79.4	44.	73.6	92.6	84.8	77.	70.4	94.8	81.7
12.	70.4	94.8	81.7	45.	84.7	92.4	85.7	78.	73.6	92.6	84.8
13.	73.6	92.6	84.8	46.	90.4	95.4	92	79.	84.7	92.4	85.7
14.	84.7	92.4	85.7	47.	87	94	84	80.	90.4	95.4	92
15.	90.4	95.4	92	48.	76.7	96.3	82.8	81.	87	94	84
16.	87	94	84	49.	74.7	94.7	89.7	82.	90.4	95.4	92
17.	76.7	96.3	82.8	50.	88.2	90	88.8	83.	87	94	84
18.	80.2	94.7	85.4	51.	87.6	97.6	94.5	84.	65.4	85.4	81.6
19.	81.3	91.3	82.7	52.	85.3	95.4	87.6	85.	74.7	87.8	79.4
20.	74.7	87.8	79.4	53.	74.7	87.8	79.4	86.	70.4	94.8	81.7
21.	70.4	94.8	81.7	54.	70.4	94.8	81.7	87.	73.6	92.6	84.8
22.	73.6	92.6	84.8	55.	73.6	92.6	84.8	88.	84.7	92.4	85.7
23.	84.7	92.4	85.7	56.	84.7	92.4	85.7	89.	90.4	95.4	92
24.	90.4	95.4	92	57.	90.4	95.4	92	90.	87	94	84
25.	87	94	84	58.	87	94	84	91.	76.7	96.3	82.8
26.	65.4	85.4	81.6	59.	76.7	96.3	82.8	92.	74.7	94.7	89.7
27.	77.6	93.6	80.9	60.	80.2	94.7	85.4	93.	88.2	90	88.8
28.	76.4	94.3	80.4	61.	81.3	91.3	82.7	94.	87.6	97.6	94.5
29.	90.4	95.4	92	62.	74.7	87.8	79.4	95.	85.3	95.4	87.6
30.	87	94	84	63.	70.4	94.8	81.7	96.	76.7	96.3	82.8
31.	65.4	85.4	81.6	64.	73.6	92.6	84.8	97.	74.7	94.7	89.7
32.	77.6	93.6	80.9	65.	84.7	92.4	85.7	98.	88.2	90	88.8
33.	76.4	94.3	80.4	66.	90.4	95.4	92	99.	87.6	97.6	94.5
Average									80.12	92.75	85.31

East Java so far can be considered as good. It is shown by an average score of BSQ values obtained showed a number of 95.31 from the range [0-100]. But from the data also obtained information that there is service attributes that not fulfill the expectation of Mandiri Bank customers in East Java. It means, there is should be efforts to improve the serving quality for Mandiri Bank customers in East Java so able to fulfill the desires and expectation of the societies. One thing that must be improved in case of e-channel, e-Banking, sms banking and ATM, competitive interest and availability of parking lot.

IV. CONCLUSION

Service quality of banking in East Java entirely is considered as good by the customers. It means the services given by bank has fulfilled the expectation of the customers. But from the BSQ gap analysis, it was known that there were 6 variables with negative gap values, expectation average value of customers more than the service perception. The variables are (1) guarantee under the government umbrella (2) presence of E-channel, E-Banking, sms Banking and ATM services, (3) presence of comfort Banking Hall, (4) availability of parking

lot (5) competitive interest (6) loan with low interest. Beside that also there are three priority variables that should be improved by banking in East Java that is, E-channel, E-Banking, sms Banking and ATM, availability of parking lot and competitive interest.

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Combination Scheme of Aes Encryption and Error Correction Turbo Code for Cryptography of Cloud Storage

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Abstract—Cloud computing is a technology model in which resources such as computer components (processor, memory, network, storage) are no longer real problems, but abstract. One cloud service is Cloud Storage. With Cloud storage facilities, users can store digital data that is kept secret securely via the internet network. But because every data is sent through a communication line, there are obstacles in the form of noise, where noise can change and reduce the quality of the transmitted data. In general, if there is an error in the data, the system will directly send back the data to be sent back. This certainly will cause delay in the data sent. To reduce the problem, it is necessary to build a cryptographic technique used to keep data and error correction systems confidential to improve the efficiency and accuracy of the information sent. To overcome the above problems can be done through AES Cryptography techniques combined with the Forward Error Correction (FEC) Turbo Code method. The simulation results show that the data is encrypted and uploaded to Dropbox and runs well. Then the results of the analysis show that the percentage of data in the form of text, images and sound will return 100% at SNR 14 dB. In addition, there is a decrease in the Bit Error Rate (BER). In the avalanche effect simulation based on the data types in the text data, the highest avalanche effect is 56.6460% with the same data conditions, but the input buttons are different. For image data, the highest avalanche effect was 55.0781% with different data conditions but the same key was entered. As for the voice data, the highest avalanche effect is 49.6094% with different data conditions but the key is in the same input. In testing the data execution time, the greater the encrypted data the longer it takes for encryption and decryption. Thus the combination of encryption with Turbo Code can overcome the above problems.

Keywords—AES; Turbo Code; Cloud Storage;

I. INTRODUCTION

Cloud Storage is one of the technologies that is currently widely used to store data. Every data that is processed in the transmission in the cloud is also vulnerable to anyone. Another problem lies in the communication system. In communication channels generally cause errors in the form of noise interference and weakening of the signal during attenuation. This disturbance causes errors in receiving data. Data will experience a reduction in bits during transmission so that when the data reaches the recipient, the data is not the

same as the data sent. In addition, this will also cause delays in data transmission. To reduce problems, it is necessary to build a system of error correction with cryptographic techniques. In error correction communication systems are used to improve the efficiency and accuracy of the information sent.

These disturbances cause errors in receiving data. The data will experience a reduction in the bit-bit during transmission so that when the data reaches the recipient, the data is not the same as the data sent. In general, if there is an error in the data, the system will directly send back the data to be sent back. This certainly will cause delay in the data sent to reduce the problem, it is necessary to build an error correction system with cryptographic techniques to encrypt data. In the error correction communication system is used to improve the efficiency and accuracy of the information sent. Many cryptographic techniques can be used, one of which is the Advanced Encryption Standard (AES). AES cryptography is still classified in cryptography that is still safe. Security from AES is supported by the use of very large keys (128 bits, 192 bits, and 256 bits). While the error correction technique used is the Forward Error Correction (FEC) method. FEC is a method to increase data reliability in telecommunication data by correcting bit errors during transmission. Turbo Code is one of the FEC methods discussed in this study.

In this study, researchers combined AES cryptography techniques with Forward Error Correction (Turbo Code) techniques with the aim of keeping data confidential in cloud storage and increasing data reliability and accuracy. Then the cryptographic combination will be simulated for encryption and decryption of text, image and sound data in cloud storage. Then it was tested using several parameters such as BER (Bit error rate) on types of text, image and sound data, Avalanche Effect on text data types, images and sounds, execution time (encryption time and decryption time) type text data, images, and sound.

II. LITERATURE REVIEW

A. Data Communication

Data communication is the process of delivering information from one place to another. There are several elements that must be available, namely data sources

(source), transmission media that carry data sent from the data source to the third element, namely the receiver (receiver). If one element does not exist, communication cannot be done [4]. The following is a general description of data communication, there are five components contained in communication.

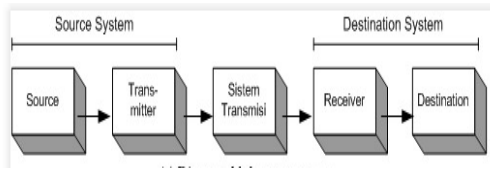


Fig. 1. . DataCommunication Model [4].

B. Advanced Encryption Standard (AES)

AES is a type of cryptographic technique established by the United States standard institution named NIST (National Institute of Standards and Technology). AES was taken from the selection of the competition held by NIST and determined by Rijndael as the AES algorithm.

AES uses components that always have an inverse with a 128-bit block length. The AES key can have a key length of 128, 192,256 bits. AES encoding uses a repetitive process called round. The number of rounds used by AES depends on the length of the key used. The round key is generated based on the given key [5].

C. Turbo Code

Turbo Code is a new paradigm for forward error correction. This Turbo Code managed to achieve error correction performance nearing the limits of Shannon's theory. For the BER value (bit error rate) and the rate of code $\frac{1}{2}$, Eb / No is 0.7 dB [6].

1) Turbo Encoder

In the encoder, the input will be divided into two lines. The first path leads directly to the output. While in other lines will be passed through interleaver. Interleaver is in charge of scrambling input into certain models. The output of the interleaver is then passed through two encoders. The encoder is in the form of Recursive Systematic Convolutional (RSC). In the redundancy encoder is applied to this process. The output of the two encoders is in the form of bits, if one encoder produces a low bit then the output from the other encoder produces high bits [7].

2) Turbo Decoder

At the decoder, symeric databits and databits from the two encoders are input. In the process the decoder will decode various entries into the sequence. Then the data will be processed through feedback feedback. The decoder will repeat the process to translate the input provided. After several repetition processes, it can estimate the data that has been sent [7].

D. Avalanche Effect

One characteristic to determine whether or not a cryptographic algorithm is to look at the Avalanche Effect. Small changes in plain text with a total of 128 bits and keys will cause significant changes to the generated cipher text. Or

in other words, changing one bit in plaintext (with a total of 128 bits) and key (a maximum of 128 bits) will result in changes in many bits in the cipher text [15.]. An Avalanche Effect is said to be good if the bit changes produced range from 45-60% (about half, 50% are very good results). The more bit changes that occur, the harder the cryptographic algorithm will be solved [13]. The value of Avalanche Effect is formulated as follows [14]:

$$\text{Avalanche Effect} = \frac{\sum \text{changed bits in cipher text}}{\sum \text{Total of bits in cipher text}} \times 100\% \quad (1)$$

E. Bit Error Rate

The Bit Error Rate or commonly abbreviated as BER, is the number of bits received from the data stream through a communication channel that has changed due to high noise. The signal indicates, the information received on the receiver side undergoes many changes during transmission. The working principle of calculating BER here is generally an XOR function between two data, where if the XOR result is 1, then there is one error bit. The BER calculation continues, until all the bits in the information signal are transmitter-XOR with the signal resulting from demodulation on the receiver side. Percentage of BER is calculated based on the ratio between the number of bits that are errors with the total number of bits [6]. The general equation of BER can be written in the following equation [16]

$$\text{BER} = \frac{\sum \text{Number of bits error}}{\sum \text{Number of bits}} \quad (2)$$

F. SNR (Signal Noise to Ratio)

SNR (Signal To Noise Ratio) is the ratio of signals received to surrounding disturbances. The following are the quality categories of SNR. The following is the SNR calculation formula in decibels (dB) [15]:

$$\text{SNR} = 10 \log_{10} \left(\frac{S}{N} \right) \quad (3)$$

G. Cloud Computing

Cloud Computing consists of two words, Cloud and Computing. Where Cloud means cloud, but what is meant here is the internet network, while Computing means Computing, which when combined means cloud computing. Cloud Computing is a computational / computing model where resources such as processor / computing power, storage, network and software become abstract and are provided as services on the network / internet using remote access patterns.

H. Dropbox

Dropbox is a web-based service operated by Dropbox, Inc. Dropbox uses a cloud computing system that allows users to store and share data and data with other users on the internet using data synchronization. Dropbox was founded in 2007 by Massachusetts Institute of Technology (MIT) graduates Drew Houston and Arash Ferdowsi with initial capital obtained from Y Combinator. Dropbox provides free and paid services with a variety of options. When compared to other similar services, iPad offers

a relatively large capacity for users on a variety of operating systems. Besides being accessible in the browser, Dropbox also provides a client application that can allow users to process data and automatically synchronize on dropbox on the internet [9].

III. RESEARCH APPROACH

This chapter discusses the process of designing a combination of AES and Turbo Code cryptography for encryption and decryption in cloud data storage.

A. Application Contexts Diagram

This section describes the application context diagram of the application diagram.

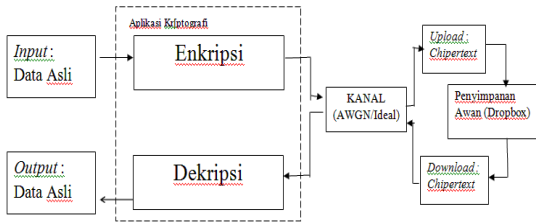


Fig. 2. Application Contexts Diagram

In the context diagram above is a form of application workflow encryption and decryption of data in securing data on cloud storage. Users will enter in the form of large data. After the user selects the data, enter the encryption process performed by the cryptographic application. From the encryption process produces an output in the form of ciphertext and the data will be stored in cloud storage. In the process of downloading data, ciphertext will pass the decryption process first and then the data can be seen by the user. For the implementation of AES-Turbo Code encryption and decryption is done in the cryptographic application section.

B. Flowchart Application

In this section it is explained in the flowchart shown in Fig. 3.

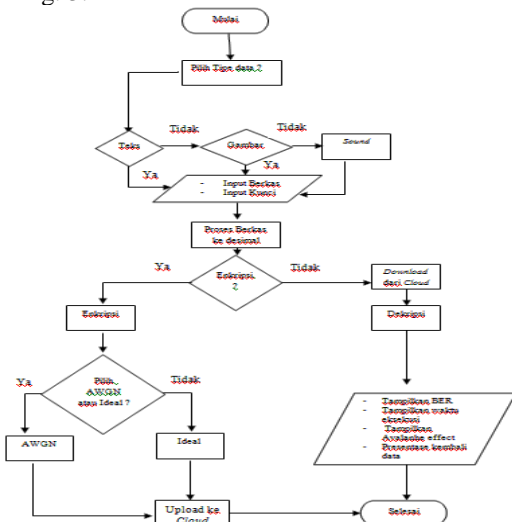


Fig. 3. Flowchart Application Combination Scheme AES and Turbo Code.

C. Flowchart Algorithm Combination Scheme AES and Turbo Code

In this section, it is explained about combining the AES algorithm with Turbo Code which is contained in the flow diagram found in Fig. 4.

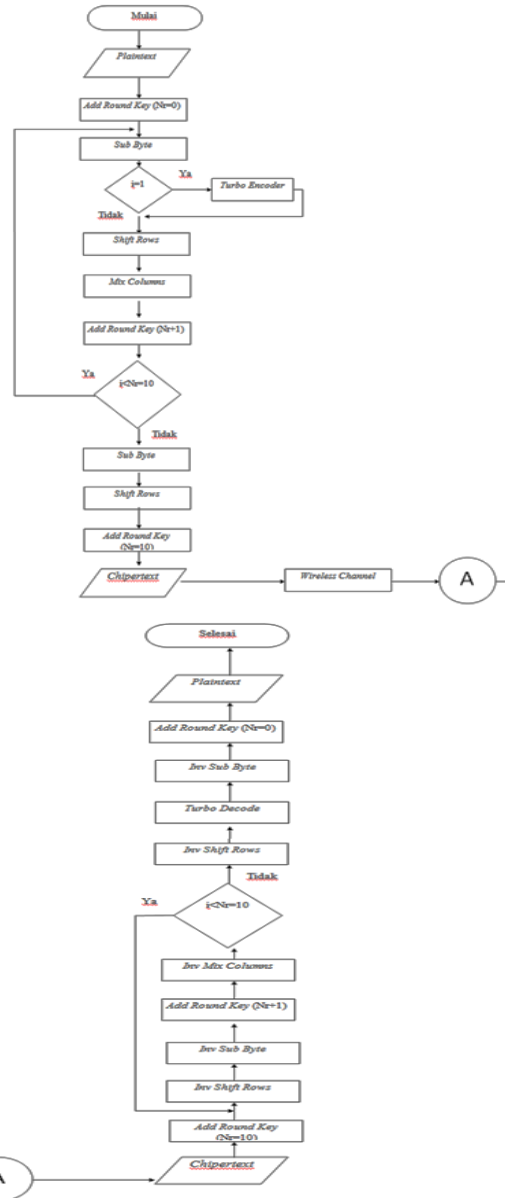


Fig. 4. Flowchart Algorithm combination Scheme AES and Turbo Code[10].

On the Turbo Code the decoder will return and that has been affected by noise. This is where the iteration of the decoder is run. Convert bytes to data: It is a process of returning data in the form of numbers into a complete data.

IV. RESULT AND ANALYSIS

The next stage is testing the combination of AES and Turbo Code. This test is conducted to determine the performance of AES and Turbo Code combinations on AWGN and Ideal channels. As well as security from a

combination of AES and Turbo Code. There are several things that are measured namely BER performance, avalanche effect and execution time.

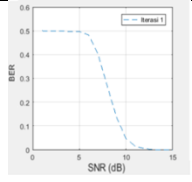
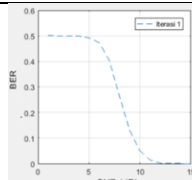
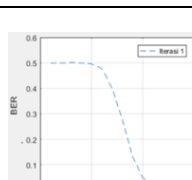
A. Performance BER (Bit Error Rate)

BER testing is a test that is done in order to find out the error bits on the AWGN channel and the ideal channel. The BER test is carried out on a different data with the SNR and decoded iterations as above. The following is the result of the BER performance testing of different data:

1) Performance BER on AWGN Channel

The following is the result of the simulation on the AWGN channel (see in Table I).

TABLE I. PERFORMANCE BER (BIT ERROR RATE) ON AWGN CHANNEL.

Graph	Parameter Performance	Output
	- Text data - Size 5142 byte - Channel AWGN - SNR (0dB - 15dB) - Iteration Decoder = 1	On SNR to 0 to 5th SNR there is no decrease in BER. A significant decrease occurred in the 5th to 12th SNR. Then at SNR to 13 to 15, the BER graph that occurs is a constant decrease at point 0. This indicates that the data is free from bit errors.
	- Image data - Size 8550 byte - Channel AWGN - SNR (0dB - 15dB) - Iteration Decoder = 1	On SNR to 0 to 5th SNR there is no decrease in BER. A significant decrease occurred in the 5th to 13th SNR. Then at SNR to 13 to 15, the BER graph that occurs is a constant decrease at point 0. This shows that the data is free from bit errors.
	- Sound data - Size 6048 byte - Channel AWGN - SNR (0dB - 15dB) - Iteration Decoder = 1	On SNR to 0 to 5th SNR there is no decrease in BER. A significant decrease occurred in the 5th to 13th SNR. Then at SNR to 13 to 15, the BER graph that occurs is a constant decrease at point 0. This indicates that the data is free from bit errors.

B. Performance BER on Ideal Channel

In the ideal channel BER performance against various types of data can be seen in the picture below:

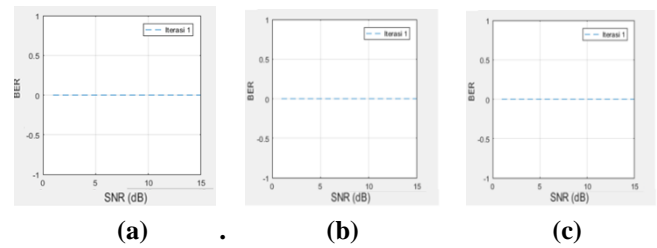


Fig. 5. Graph BER on Ideal Channel Graph BER data type Text (a), Graph BER data type Image (b) and Graph BER data type Sound (c).

In the picture above (Fig. 5) shows a flat line because the ideal channel is a channel with ideal conditions so that data sent and received is not damaged in the data bit.

1) Performance Avalanche Effect

Following are the results of the Avalanche Effect test can be seen in table II.

TABLE II. THE RESULT TEST OF AVALANCHE EFFECT AES-TURBO CODE.

Scenario	Condition data	Data Type	Key	Avalanche Effect
1	Same Key and different data, size with 128 bit	Text	12333	47.6563%
2	Different Key and Same data, size with 128 bit	Text	12334 12333	56.6460%
3	Same Key and Different data, size with 128 bit	Image	12333	55.0781%
4	Different Key and Same data, size with 128 bit	Image	12334 12333	50.3906%
5	Same Key and Different data, size with 128 bit	Sound	12333	49.6094%
6	Different Key and Same data, size with 128 bit	Sound	12334 12333	44.5313%

In table II it can be seen that, of the six scenarios that were tested, they had different avalanche effects for each data. In the text data, the highest avalanche effect is 56.6460% with the same data condition, but the key entered is different. For image data, the highest avalanche effect is 55.0781% with different data conditions but the key entered is the same. Whereas for sound data, the highest avalanche effect is 49.6094% with different data conditions but the key entered is the same.

2) Performance Encryption and Decryption Time

This simulation was carried out by comparing the time of execution to various types of data and channel types. This simulation is done with input data namely data type (text, image, and sound), SNR 15 dB, and 1 iteration. The following is a table of the results of the simulation that have been conducted:

TABLE III. TIME ENCRYPTION AND DECRYPTION AES-TURBO CODE ON IDEAL CHANNEL.

Data Type	Size Data(byte)	Time (sec)	
		Encryption	Decryption
Text	5142	33.8018	33.3823
	17314	101.48	120.334
Image	1587	13.8812	9.48505
	8550	52.0146	55.2579
Sound	6048	39.1264	38.8202
	23680	152.985	172.009

TABLE IV. TIME ENCRYPTION AND DECRYPTION AES-TURBO CODE ON AWGN CHANNEL

Data Type	Size Data(byte)	Time (sec)	
		Encryption	Decryption
Text	5142	27.317	33.7881
	17314	85.7838	121.532
Image	1587	6.69505	9.08504
	8550	39.3284	125.292
Sound	6048	28.2518	39.7171
	23680	119.56	171.275

V. CONCLUSION

From the results of the research that has been done, some conclusions can be drawn as follows:

- Data text type, image and sound that are encrypted with a combination of AES and Turbo Code then simulated by adding the AWGN on the data type can be decrypted again at SNR > 10dB with an average percentage of the text data type of 99.45%, image of 99.37% and sound is 99.38%. For SNR < 10, the average percentage of each data is for the text data type of 23.49%, the image of 23.76% and the sound of 24.70%.
- The results of the simulation avalanche effect based on the data type that is in the text data obtained the highest avalanche effect of 56.6460% with the same data condition but the key entered is different. For image data, the highest avalanche effect is 55.0781% with different data conditions but the key entered is the same. Whereas for sound data, the highest avalanche effect is 49.6094% with different data conditions but the key entered is the same.
- The time of execution of encryption and decryption on a combination of AES and Turbo Code, the time required for encryption and decryption on the AWGN channel is longer than in the ideal channel. The average time needed is around 6 seconds on the ideal channel while for AWGN channels is around 32 seconds.
- Overall the combination method of AES Cryptography and Error Correction Turbo code is a new cryptographic method that has better performance than AES Cryptography for cloud storage at SNR > 10 dB..
- This research can then be compared with other algorithm (MAP, Log-MAP, Max-Log-MAP & SOVA) turbo code. to find a balance between the performance of decoding and the complexity of implement.[17].

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Prototype of Heat Exchanger U-Tube Model Shell and Tube Counter Flow

(First Project)

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Abstract— This research aimed to discuss the manufacturing of The Heat Exchanger Cooler Type U-Tube with 2 types of fluid, water as cold fluid and oil as hot fluid, which flow in opposite direction. There were 2 methods which used in this research, the empirical method and the experimental method. The empirical method used some formulas to find out the impact of using U-Tube as a heat exchanger, while the experimental method used by taking data in real time. There were 2 different pumps used in this heat exchanger, water pump and oil pump. The average oil pump flow rate was about 9.64 L/min and the temperature was about 95.17°C. On the other hand, the average water pump flow rate was about 30.42 L/min and the temperature was about 30.50°C. The material of tubes was made of a copper tube which had 4mm inner inlet diameter and 6mm outer inlet diameter. There was 31 U shaped copper tubes in total which had 1000mm length for each. Based on the experimental method, it was proved that this type of heat exchanger made 58.83% of temperature dropped.

Keywords—heat exchanger; counter flow; U-Tube; fluids; cooler; flowrate

I. INTRODUCTION

Heat exchangers are devices that facilitate the exchange of heat between two fluids that are at different temperatures while shielding them from blending with one another. Heat transfer in a heat exchanger usually involves convection in each fluid and conduction through the wall separating the two fluids. In the analysis of heat exchangers, it is convenient to work with an overall heat transfer coefficient U that accounts for the contribution of all these effects on heat transfer [3]. The rate of heat transfer between the two fluids at a location in a heat exchanger depends on the magnitude of the temperature difference at that location, which varies along the heat exchanger. Heat transfer equipment that uses fluid to another fluid is a water heater - filler - open kettle (open feed - water heater), but what is more commonly used is a heat exchanger where one fluid is separated from the other fluid by a wall or bulkhead that is passed by heat, Recuperator type heat exchangers are pipe-shaped heat exchangers in the pipe. There are various ways to increase the effectiveness of heat exchanger, according to mechanical engineering by increasing the coefficient of heat transfer of convection, increasing the surface area of the heat exchanger and increasing the

temperature difference to reach the specified temperature. The second way to achieve the expected temperature quickly is to use the control method, with input fluid temperature, pump a shell speed, cooling fan speed and expected output is the desired fluid temperature. In a heat exchanger that includes a tube bank, the tubes are generally set in a (shell-and-tube heat exchanger), particularly when the liquid is a fluid, and the liquid flow through the space between the tubes and the shell. Flow through the tubes can be dissected by thinking about move through a solitary tube, and duplicating the outcomes by the quantity of tubes. This is not the case for flow *over* the tubes, however, since the tubes affect the flow pattern and turbulence level downstream, and thus heat transfer to or from them. Therefore, when analyzing heat transfer from a tube bank in cross flow, we must consider all the tubes in the bundle at once.

II. LITERATURE REVIEW

A. Previous Research

Budiarto [1], in his research said that the variations in static twisted tape length and variations in hot oil fluid discharge has a real effect on pressure drop on counter flow oil coolers, the results of the research are the longer static twisted tape installed. in the inner tube heat exchanger and with the increasing flow of hot fluid flow, in each test with the same variation of hot oil fluid discharge will increase pressure drop, and effectiveness. The relations between static twisted tape length variation to pressure drop on the inner tube caused by static twisted tape or without static twisted tape installation on each variation of hot fluid discharge. In *Fig 1* it can be seen that the pressure drop is directly proportional to the increasing length of static twisted tape and the increase in heat oil discharge.

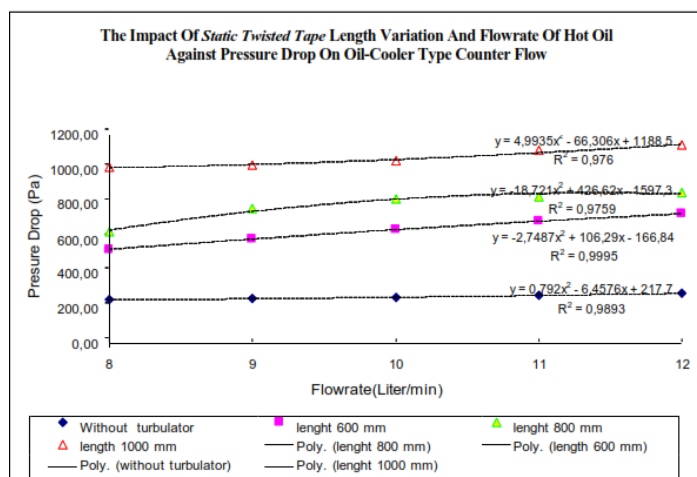


Fig. 1. Graph of the influence of the static twisted tape length variations and the effect of variations in hot oil fluid

Hidayat [10], in his seminar entitled 'Application of Fuzzy Logic to Control PID Parameter Tuning On The Setting Temperature Of The Liquid Shell And Tube Heat Exchanger'. The design of its hardware uses an LM35 as a temperature sensor, DC servo motor used to drive the tap (valve), a heating (heater) and 300 watt power with an AC voltage source and a microcontroller that serves as the center of control and PC, reference testing with fixed input as shown in Fig 2 and Fig 3.

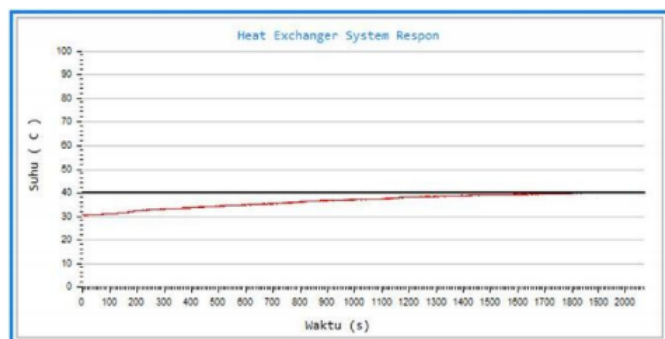


Fig. 2. System response time of Fuzzy PID method with fixed reference

Fuzzy control for tuning PID parameters can produce a good control signal so that it can produce a good response too.

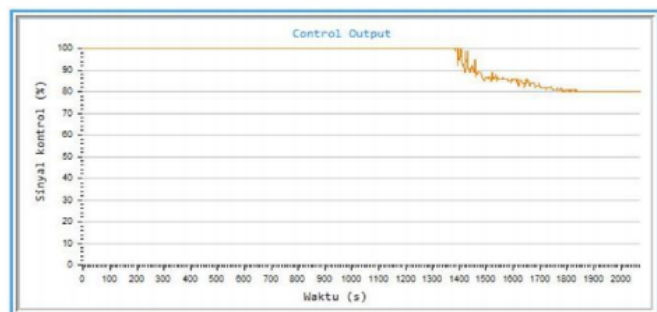


Fig. 3. Fuzzy PID output signal control with fixed reference.

In his research with fuzzy logic control, a PID parameter can corresponds to the error system, generate control signals and stable response systems, a good sensor results with a value of error about 0, 08°C, testing with set points go up or down, control signals can follow the settling points.

Ekasari [5], in his research entitled 'Controlling Fluid Temperature in Heat Exchanger Using Model Of Predictive Control (MPC) Algorithm', concluded that MPC belongs to the concept of process controller-based design concept, with the controller design results very depending on the validity of the approach model used, the most suitable MPC is to use 20 horizon predictions and 4 horizon controls and steady state time requires 70 seconds.

Control of the linear plant approach with the MPC controller can produce a stable response without overshoot and according to the set point value of 70°C at a fixed load or varying load of about 20% of the nominal load with a steady state of 35 seconds. Padhee [7], in his research entitled 'Controller Design For Temperature Control Of Heat Exchanger System' the focus of his research was on graphics analysis of several controller techniques that will be applied to regulate the temperature of the heat exchanger, from the simulation it was found that the internal model control has a higher performance value than feedback and feedback plus feed-forward controller methods, the implementation of using the PID controller shows a high degree of overshoot on the same settling time.

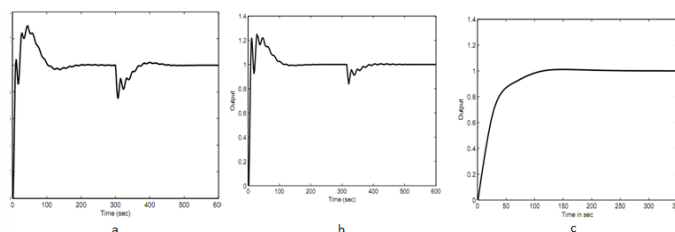


Fig. 4. Set point and load disturbance response using (a) PID controller (b) feedback plus feedforward controller (c) internal controller model.

B. Basic Theory

Heat energy is a form of energy that can be moved from one system to another system as the result of a difference in temperature. On steady flow fluid in a channel where there is one inlet and one outlet then the flow rate of a fluid mass that enters will equal the mass flow rate of the fluid in or out, or $m_{in} = m_{out} = m$. If the liquid does not take the necessary steps then the extent of the heat energy that transferred will be equivalent to the energy change of the system, At the point when the kinetic inactive and potential energies are unimportant, which is typically the case, and there is no work interaction, the energy balance for such a steady-flow system reduces to Fig. 4.

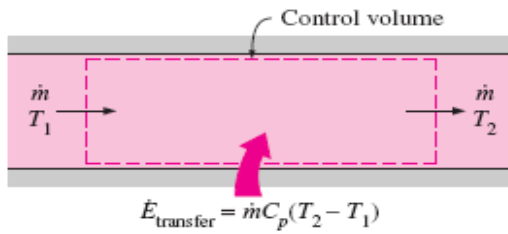


Fig. 5. Transfer of heat energy to a system with volume control

The amount of heat energy in the system can be expressed by the following equation:

$$\dot{Q} = \dot{M} C_p \Delta T \quad (1)$$

with:

\dot{Q} = heat energy rate

\dot{M} = fluid mass flow rate (kg/s)

C_p = specific heat at a constant pressure (J/kg)

ΔT = temperature change (°C)

Heat transfer can be defined as the transfer of energy from one system to another as a result of temperature differences, this energy transfer always occurs from a high temperature system to another system that has a lower temperature and will stop after both systems reach the same temperature, the temperature difference is the main requirement for the transfer of the system. if the two systems have the same temperature, there will be no heat transfer in the second



Fig. 6. Heat exchanger type U-Tube

The conduction heat transfer rate was stated by J.B.J. Fourier in 1822, namely the amount of proportional heat transfer rate of heat to the surface area through heat, temperature difference, and thermal conductivity of material, but inversely proportional to the thickness of the surface traversed by heat.

$$\dot{Q}_{cond} = -kA \frac{(T_2 - T_1)}{\Delta x} \quad (2)$$

Which:

\dot{Q}_{cond} = conduction heat transfer rate (W)

K = thermal conductivity material (W/m °C)

A = heat transfer surface area (m²)

$T_2 - T_1$ = Temperature difference of heat transfer surface (°C)

Δx = thickness of heat transfer surface in the axis x (m)

Consider a fluid entering a circular tube at a uniform velocity. As in external flow, the fluid particles in the layer in contact with the surface of the tube will come to a complete stop. This layer will also cause the fluid particles in the adjacent layers to slow down gradually as a result of friction. To compensate for this velocity decrease, the velocity of the liquid at the waist of the tube should increment to keep the mass stream rate through the tube consistent. Thus, a velocity limit layer creates along the tube. The thickness of this boundary layer increases in the flow direction until the boundary layer reaches the tube center and thus fills the entire tube, as shown in Fig 7. The region from the tube inlet to the point at which the boundary layer merges at the centerline is called the hydrodynamic entrance region, and the length of this region is called the hydrodynamic entry length L_h . Flow in the entrance region is called hydrodynamically developing flow since this is the region where the velocity profile develops

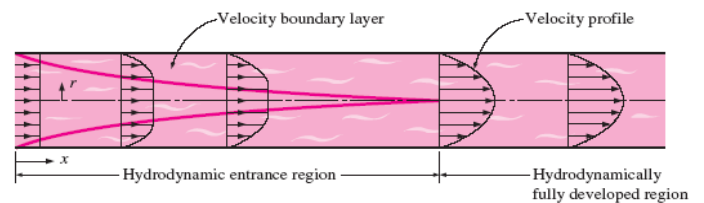


Fig. 7. Example of a Hydrodynamic limits

The locale of flow over which the thermal limit layer creates and achieves the tube center is known as the thermal entrance region, and the length of this area is known as the thermal section length (L_t). Flow in the thermal entrance region is called thermally developing flow since this is the region where the temperature profile develops. The region beyond the thermal entrance region in which the dimensionless temperature profile expressed as $(T_s - T)/(T_s - T_m)$ remains unchanged is called the thermally fully developed region. The area in which the flow is both thermally and hydrodynamically created and in this manner both the velocity and dimensionless temperature profiles stay unaltered is called completely developed flow.

III. RESEARCH APPROACH

A. Prototype Design

The prototype of heat exchanger uses two different materials for shell and tube, materials for shell tube using is acrylic pipes and for tubes is using copper, design of heat exchanger for shell pipe has an inner diameter of 256 mm and an outer diameter of 800 mm, with a shell length of 1000 mm, Whereas for the pipe tube of heat exchanger uses copper pipe with dimensions of inner diameter is 4 mm and outer diameter is 6.3 mm with tube length is 1000 mm

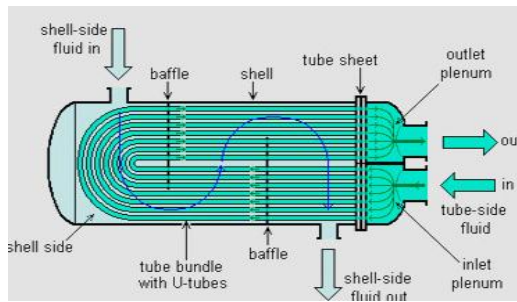


Fig. 8. U-Tube Heat Exchanger

Another supporting device is Pump, there are two types of pumps that are used: water pumps and oil pumps with different specifications. The specification of the water pump as shown in Fig 9.



Fig. 9. Water pumps specification is used in prototype Heat Exchangers

The dimensions of the water pump as follows:

- Shimizu pump brand
- 50 Hz working frequency
- Suction depth of 10-20 meters
- Height of 9 meters of water distribution
- Discharge of 10-18 liters / minute
- 40 °C operating temperature.

The use of inlet and outlet pipes is determined by a ¾ inch pipe, the pipeline groove will be determined later by following the frame shape of the heat exchanger prototype. For the oil pump will use a modified water pump in the windmill/fan of the pump, the Windmill/ fan will use metal material so that it will not interfere with the performance of the pump itself. The spesification of the oil pump as shown in Fig. 9.

The oil pump dimensions used are:

- Brand sanyo oil pump
- 125 Watts of pump power, 220 V - 50Hz
- 9 meter suction power
- 30 meter flow height
- Discharge of 30 liters / minute
- Maximum water temperature of 45°C

B. Method

There are two methods used in this study i.e.:

1) *Teoritical/Emprical Method*: This method uses the formula to do a quantity of heat transfer that occurs in the tube, the calculation of the heat exchanger prototype analysis, determined by statistical variable:

- Discharge on water pump spcified by 10 liters/min
- Flowrate at the oil pump specified by 5 litres/minute
- $T_{cold, in}$ (water-in temperature) = 25 °C.
- $T_{hot, in}$ (oil-in temperature) = 60 °C.

To specify the calculation of this research are used a few formulas include:

- calculation the final temperature of the oil-out tube

$$T_{oil\ out} = T_{h(out)} = T_s - (T_s - T_i) \exp\left(-\frac{A_s \cdot h}{M^o \cdot C_p}\right)$$

IV. PRACTICAL/ACTUAL METHOD

Practical/actual method is retrieving data from a device that is read by sensors installed around the tube, the data that will be taken is the data from the the temprature sensor and flowrate sensor.

V. RESULT

The process of making a Heat Exchanger with a U-tube shape requires some materials and tools, the tube bending technique requires more concentration, if it carelessly causes the copper pipe (tube) to be deformed so the diameter will narrow which will result in clogging of hot fluid flow in the form of oil, and cause oil flow discharge cannot be controlled. The worst damage can cause oil pump performance cannot be maximal. The making of shell and U-tube is made in the Mechatronics Laboratory of Trunojoyo University of Madura shown on Fig. 11.



Fig. 10. Building Process of U-Tube Model

The resulting U tube shape is not symmetrical, because the U tube combat area is forced to be the same as the linear U tube shape. The U tube area must be the same to be able to compare the test results between the heat exchanger in the form of linear U tube and U tube.

The next process is the installation of the tube into the shell, and test the shell leak or U tube that has been made. If the shell and U tube are suitable, the installation of the Heat Exchanger prototype has been made, laying the shell and U tube, as in Fig. 11.



Fig. 11. Installing the shell and U tube

The next step is to do mechanical testing and calculation. As in previous studies with the linear form of shell and tube, two data will be generated, namely Empirical data and Actual data.

Empirical data, is a mechanical calculation data by following the heat transfer step according to the material used. Actual data is data generated from the device directed, recorded and presented in the form of tables. Empirical data calculations, are determined by specifying numbers:

- The discharge at the water pump is determined by 30 liters / minute
- The discharge at the oil pump is determined to be 9 liters / minute
- T-cold (inlet water temperature) = 29 °C.
- T-hot (inlet oil temperature) = 100 °C

Actual data is data recorded from sensor output that has been installed on the prototype heat exchanger, there are sensors and actuators installed are:

- Temperature sensor for water-in
- Temperature sensor for water-out
- Temperature sensor for oil in
- The temperature sensor for the exit
- Flow sensor for water-in
- Flow sensor for oil in
- DC motor valve to regulate the incoming water faucet
- DC motor valve to adjust the oil valve in

The results of the data record process are carried out as in Table I and Table II.

TABLE I. ACTUAL WATER DATA

Flowrate (L/min)	Water Passed/mL	Water-in (°C)	Water-out (°C)
22.35	372	29.33	31.88
29.79	868	30.79	32.15
30.55	1377	30.75	32.27
30.55	1886	30.76	32.79
30.58	3907	30.76	32.76
30.76	7492	31.13	35.16
30.98	8008	30.76	33.30
30.76	9545	31.71	32.30

Flowrate (L/min)	Water Passed/mL	Water-in (°C)	Water-out (°C)
30.76	10057	30.76	32.76
30.98	12124	30.76	32.76
31.01	13668	30.27	32.79
31.19	15738	30.76	31.25
31.19	17288	29.79	33.20
31.01	18838	31.23	33.11
30.98	19354	30.76	31.74
30.98	20384	30.62	32.48
30.98	20900	30.27	33.20
30.98	22447	30.27	32.23
30.98	23989	29.30	33.32
30.98	23989	29.30	33.32
AVERAGE			
30.42		30.50	32.74

TABLE II. ACTUAL OIL DATA

Flowrate (L/min)	Water passed (mL)	Oil-in (°C)	Oil-out (°C)
7.94	203	100.10	36.62
8.83	350	99.12	36.62
8.83	497	94.24	36.13
9.27	651	97.66	38.09
9.27	805	94.73	32.23
9.47	962	93.26	36.62
9.70	1123	95.21	36.13
9.70	1284	90.82	37.60
9.91	1449	94.24	37.11
10.13	1617	94.73	36.62
10.10	1785	92.77	38.09
9.90	1949	92.77	39.55
10.13	2117	94.24	38.57
10.11	2285	92.77	39.06
10.12	2453	97.17	38.57
10.11	2621	96.19	39.55
9.90	2785	92.77	40.53
9.91	2950	98.14	41.50
9.70	3111	97.17	41.99
9.70	3272	95.21	41.99
AVERAGE			
9.64	1713,45	95.17	36,34

Based on Table I and Table II, the prototype of Heat Exchanger U-Tube model shows a decrease in oil temperature, so, heat transfer is proven to come out of U-tube into the incoming water as a cooler.

The next step is empirical data, namely the calculation of mechanical heat transfer data and heat transfer from U-tube with copper material.

VI. CONCLUSION

Based on the results of testing and discussion of Prototype of Heat Exchanger U-Tube Model Shell and Tube Counter Flow there are some conclusions can be formulated as follows:

1. The prototype heat exchanger uses two different materials for shell and tube, materials for shell tube using is acrylic pipes and for tubes is using copper.

2. Based on the result of this project we can solved that the temprature drop on oil tube was occured. Which $T_{oil\ in}$ was $95.17^{\circ}C$ to $T_{oil\ out}$ was $36.34^{\circ}C$ or we can conclude that the temprature drop is about 58.83% , Meanwhile, the water temprature raising until 2.24% due to heat transfer from hot oil to water.
3. In this paper only taken sample from practical method and actual data from the device, for the second method (empirical methode which is the calculation of heat transfer using some formula) will be describe and compare the result of this reasearch using practical method and empirical method

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The Influence of Node Velocity and Traffic Congestion on The Performance of AODV in MANET

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Abstract—There were many researches that discussed about performance of Ad hoc on Demand Distance Vector (AODV) in Mobile Ad-hoc Network (MANET). Some of them used mobile velocity and traffic congestion as variables in their observation. This research becomes very important because the writer of this paper was not sure of the result and the analysis of some previous research. So, this paper aims to explore about the impact of node velocity and traffic congestion to the performance and characteristic of AODV in MANET. The transport agents used are Transmission Control Protocol for File Transfer Protocol (TCP/FTP) and User Datagram Protocol for Constant Bit Rate (UDP/CBR). The research is applied by using Network Simulator 2 (NS-2). The performance is measured over some parameters, namely Overhead Routing (RO), Normalized Routing Load (NRL), and Packet Delivery Ratio (PDR). The contribution and the results obtained proved that the node velocity and traffic congestion can degrade the performance of AODV in MANET. It argued the other previous research claim that the node speed or velocity did not have influence to the performance of AODV MANET.

Keywords—Node velocity; traffic congestion; AODV; MANET

I. INTRODUCTION

The development of Computer network technology is very fast. Mobile network is the most popular and developed for next generation network. MANET is one among the answers. It is one of the wireless network technologies that consist a set of interconnected nodes to communicate each other. So, it works dynamically [1]. The network topology can change rapidly in accordance with existing conditions. Each node applies as a user and router simultaneously. So, routing protocol is very needed here. Router calculates and finds the shortest path of network. One of the most popular routing protocol is AODV.

There are many papers in routing protocol of MANET. [2] analyzed the characteristic of TCP and UDP on MANET with AODV routing protocol. Some performance parameters used are PDR, End-to-End Delay, Packet loss, RO, and Throughput. The research variable is pause time. [3] also analyzed the characteristic of TCP and CBR on MANET with different scenario, different parameters and different variables of the observations. even farther, there was a paper that proposed to enhance the routing protocol AODV on MANET. The

performance parameters observed are End to End Delay, PDR, and Throughput. While the variable is amount of nodes [4]. The amount of node was used to apply the traffic conditions, namely light traffic, medium until congestion.

Comparison model was also used in the performance analysis of this topic. [5] and [6] compared the performance of TCP and UDP with different routing protocols such as AODV, DSDV and DSR on MANET. Even further, [7] compared the Performance of UDP/CBR and TCP/FTP on different Routing Protocols in VANET.

Some papers discussed about the influence of mobility speed on the network performance in MANET. Some of them investigated the influence of mobility speed on different routing protocol (AODV, DSDV and DSR) in MANET [8-10] discussed the influence of mobility speed on throughput in comparison of TCP/FTP and UDP/CBR in AODV MANET. It showed on graph of the research result that the increasing of mobility speed tends to have no effect on the throughput value. [11] also discussed the influence of maximum speed on throughput in comparison of TCP and CBR in AODV MANET. It showed on the research result that the increasing of maximum speed tends to degrade packet loss and average delay. The researcher of this paper was not satisfied with the result and the analysis of the other papers mentioned above. So, this paper aims to investigate the influence of mobile velocity and traffic congestion on the characteristic of AODV MANET. The transport agents used are TCP/FTP and UDP/CBR. The research is applied by using Network Simulator 2 (NS-2). The assessment uses some parameters, namely PDR, NRL, and RO. And the results will be compared with the other papers mentioned above.

II. RESEARCH METODOLOGY

In this paper, the simulation scenario is designed to investigate the influence of mobile velocity and traffic congestion on the performance of TCP/FTP and UDP/CBR network in MANET using NS-2. The routing protocol used here is AODV. In General, the system can be illustrated in Fig. 1 below.

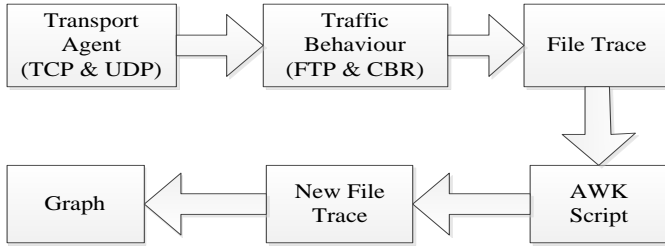


Fig. 1. Block diagram of the simulation with NS-2

Transport agent TCP is used for traffic behavior of FTP type, while UDP is used for traffic behavior of CBR type. The simulation output is a trace file. The values of RO, NRL and PDR can be calculated by using awk script. New trace file is produced from this process and it is applied to display graphs of the performance [12].

Routing Overhead (RO) is a total number of routing packets sent by a routing protocol in every delivery of data packet. This parameter is used to calculate the efficiency of the performance of the routing protocol at transmitter. The larger value of RO, the less network efficiency.

$$RO = \frac{\sum \text{Routing Packets Sent}}{\sum \text{Data Packets Sent}} \quad (1)$$

Normalized Routing Load (NRL) is number of routing packets transmitted on every data packet received at the destination. So, the value of this parameter is viewed from the terminal node. This parameter is used to calculate the efficiency of the performance of a routing protocol.

$$NRL = \frac{\sum \text{Routing Packets Received}}{\sum \text{Data Packets Received}} \quad (2)$$

Packet delivery ratio (PDR) is comparison of data packets sent to data packets received.

$$PDR = \frac{\sum \text{Data Packets Received}}{\sum \text{Data Packets Sent}} \quad (3)$$

Number of nodes in this simulation is varied from 10 nodes, 20 nodes until 30 nodes. Number of connection is also varied from 1 connection, 3 connections until 6 connections. This condition is applied to produce condition of light traffic until congested network. The nodes are set in motion. Each movement of nodes are set in random direction. The velocity of nodes is also varied from 5 m/s, 10 m/s until 20 m/s.

The simulation is applied in two scenario. In the first scenario, variation of nodes velocity is combined with variation of connection number. While in the second scenario, variation of node number is combined with variation of connection number. The simulation time is 60 s, with area X=1000 and Y=1000.

III. RESULT AND DISCUSSION

The values of RO, NRL and PDR from the first scenario of the simulation are shown in table 1, table 2 and table 3.

As shown in table 1, the values of RO on UDP/CBR is smaller than TCP/FTP, either on 1 connections, 3 connections, and 6 connections. The average of RO are 0.003 for UDP/CBR and 0.086 for TCP/FTP. It happens because TCP is connection oriented protocol. TCP always rearranges data packets in each order specified. TCP applies acknowledgement, error detection and error correction mechanism, so it decreases the efficiency of transmission and enlarges the value of RO. Unlike TCP, UDP is connectionless protocol. Data is sent across the network in chunks independently.

TABLE I. THE VALUES OF RO OF THE FIRST SCENARIO

Velocity	Connection	RO	
		TCP	UDP
5 m/s	1	0.014	0.001
	3	0.061	0.003
	6	0.091	0.002
10 m/s	1	0.048	0.004
	3	0.068	0.004
	6	0.112	0.004
20 m/s	1	0.111	0.004
	3	0.139	0.003
	6	0.170	0.003
Average		0.086	0.003

The increasing of connection number from 1 connection, 3 connections until 6 connection in TCP/FTP causes the increasing of RO values sequentially 0.014, 0.061 and 0.091 for velocity 5 m/s, 0.048, 0.068, and 0.112 for velocity 10 m/s, and 0.111, 0.139 and 0.170 for velocity 20 m/s. It means that the efficiency decreases. In TCP, the increasing of connection number means the increasing of routing packets, so it influences and decreases the efficiency at transmitter or RO. But it does not happen in UDP/CBR. The increasing of connection number does not influence the RO, because the data is transmitted in chunks independently [7].

The increasing of node velocity from 5 m/s, 10 m/s until 20 m/s in TCP/FTP causes the increasing of RO values sequentially 0.014, 0.048 until 0.111 on 1 connection scenario, 0.061, 0.068 until 0.139 on 3 connections scenario, and 0.091, 0.112 until 0.170 on 6 connections scenario. It influences and decreases the efficiency of transmission or RO because the velocity of nodes can change the routing calculation. It may produce more than one routing, so it can increase the value of RO. But it does not happen in UDP/CBR. The increasing of node velocity tends to have no influence on the RO, because the data is transmitted in chunks independently.

TABLE II. THE VALUES OF NRL OF THE FIRST SCENARIO

Velocity	Connection	NRL	
		TCP	UDP
5 m/s	1	0.024	0.006
	3	0.025	0.110
	6	0.160	0.123
10 m/s	1	0.111	0.034
	3	0.143	0.047
	6	0.203	0.084

Velocity	Connection	NRL	
		TCP	UDP
20 m/s	1	0.234	0.066
	3	0.182	0.026
	6	0.269	0.070
Average		0.164	0.066

As shown in table 2, the average of NRL on TCP/FTP (0.164) is higher than UDP/CBR (0.066), because the transmitter efficiency (RO) of TCP/FTP is also higher than UDP/CBR. But the average of NRL, either on TCP/FTP and UDP/CBR are higher than the average of RO on TCP/FTP (0.086) and UDP/CBR (0.003), because not all transmitted data can be received in receiver. A part of them may be blocked because of traffic congestion or missed in channel.

In the same manner as RO, the increasing of connection number from 1 connection, 3 connections until 6 connection in TCP/FTP causes the increasing of NRL values sequentially 0.024, 0.025 and 0.160 for velocity 5 m/s, 0.111, 0.143, and 0.203 for velocity 10 m/s, and 0.234, 0.182 and 0.269 for velocity 20 m/s. It means that the efficiency of the receiver decreases. UDP/CBR also acts same characteristic with TCP/FTP. The NRL values on UDP/CBR also increases, sequentially 0.006, 0.110 and 0.123 for velocity 5 m/s, 0.034, 0.047 and 0.084 for velocity 10 m/s, and 0.066, 0.026 and 0.070 for velocity 20 m/s.

The increasing of node velocity from 5 m/s, 10 m/s until 20 m/s in TCP/FTP causes the increasing of NRL values, sequentially 0.024, 0.111 until 0.234 on 1 connection scenario, 0.025, 0.143 until 0.182 on 3 connections scenario, and 0.160, 0.203 until 0.269 on 6 connections scenario. The NRL values on UDP/CBR sequentially are 0.006, 0.034 until 0.066 on 1 connection scenario, 0.110, 0.047 until 0.026 on 3 connections scenario, and 0.123, 0.084 until 0.070 on 6 connections scenario. The faster node velocity is, the worse efficiency of NRL in TCP/FTP becomes. While on UDP/CBR, the node velocity tends to have no influence on the values of NRL.

The final parameter observed in the first scenario is PDR. The results are shown in table 3. The average of PDR on TCP/FTP (96.517%) is much higher than UDP/CBR (13.815%), because TCP is connection oriented protocol, while UDP is connectionless protocol. With connection oriented type of TCP, there is guarantee that all data transmitted reach the receiver. While, with connectionless type UDP, there is no guarantee that all packets sent reach the receiver.

The increasing of connection number from 1 connection, 3 connections until 6 connections causes the increasing of traffic load, from light traffic until congested traffic. Even, the congested traffic causes the increasing of blocking probability. So, The increasing of connection number here produces the decreasing of PDR values on TCP/FTP and UDP/CBR.

TABLE III. THE VALUES OF PDR OF THE FIRST SCENARIO

Velocity	Connection	PDR (%)	
		TCP	UDP
5 m/s	1	99.015	26.346
	3	97.017	4.248
	6	96.239	3.324

Velocity	Connection	PDR (%)	
		TCP	UDP
10 m/s	1	98.00	25.493
	3	96.583	15.888
	6	95.651	9.213
20 m/s	1	96.707	11.838
	3	95.260	21.092
	6	94.180	6.895
Average		96.517	13.815

In the same manner as RO and NRL, the increasing of nodes velocity from 5 m/s, 10 m/s until 20 m/s gives negative effect and decreases the PDR values, either on TCP/FTP and UDP/CBR.

Comparing this result to another papers, [10] presented the relationship between speed of mobile node and throughput. It showed that the increasing of mobile node speed tends to have no influence on the performance of the network (throughput). This paper shows different result that the increasing of mobile node speed causes the decreasing of the performance of the network (value of PDR).

[11] also presented the relationship between maximum speed versus NRL, the relationship between maximum speed versus average delay and the relationship between maximum speed versus packet loss. The result of that paper showed that the relationship between maximum speed and NRL can not be concluded, because it doesn't tend to be up and doesn't tend to be down. The values of NRL are fluctuating. It also showed that the relationship between maximum speed and average delay also can not be concluded, because it doesn't tend to be up and doesn't tend to be down too. The values of the average delay are also fluctuating. In other side, it also showed that the increasing of maximum speed causes the packet loss tends to degrade. It means that the faster maximum speed is, the better performance obtained. In contradiction, this paper results that the faster node velocity is, the worse performance got.

In the second scenario, node number is varied from 10 nodes, 20 nodes until 30 nodes. This variation is combined with the variation of connection, from 1 connection, 3 connections until 6 connections. In the same manner as first scenario, the performance is defined by the vales of RO, NRL and PDR. The results are shown in table 4 for RO, table 5 for NRL and table 6 for PDR.

TABLE IV. THE VALUES OF RO OF THE SECOND SCENARIO

Nodes	Connection	RO	
		TCP	UDP
10	1	0.068	0.003
	3	0.096	0.020
	6	0.084	0.005
20	1	0.369	0.005
	3	0.209	0.024
	6	0.402	0.020
30	1	0.245	0.027
	3	0.655	0.081
	6	1.183	0.093
Average		0.368	0.031

From table 4, the increasing of node number and connection number tends to increase traffic load, either on TCP/FTP or

UDP/CBR. The average of RO of 10 nodes are 0.082 for TCP/FTP and 0.009 for UDP/CBR. When the node number is 20 nodes, the average of RO becomes 0.327 for TCP/FTP and 0.016 for UDP/TCP. The average of RO becomes 0.694 for TCP/FTP and 0.067 for UDP/CBR when the node number is 30 nodes.

At congestion condition, there are many data packets that are blocked by network. It gives bigger impact on TCP/FTP than UDP/CBR, because TCP is a protocol that applies flow control. At congestion condition, TCP decreases the flow of data packets. It causes the data packets sent can be smaller than routing packets sent, so the RO value can be more than 1. This condition can be seen at table 4 when node number is 30 nodes, connection number is 6 connections, then the RO value is 1.183.

TABLE V. THE VALUES OF NRL OF THE SECOND SCENRIO

Nodes	Connection	NRL	
		TCP	UDP
10	1	0.149	0.012
	3	0.194	0.515
	6	0.178	0.146
20	1	1.012	0.045
	3	0.622	0.378
	6	1.170	0.767
30	1	1.084	0.317
	3	3.200	2.751
	6	5.637	10.156
Average		1.477	1.676

The average of NRL of the second scenario (table 5) is much higher than the average of RO (table 4). This scenario applied congested traffic. So, there are much data packets blocked by the network. It causes the average of NRL becomes higher than the average of RO. Even in the congestion condition, the NRL of UDP/CBR (10.156) is about 2 times higher than NRL of TCP/FTP (5.637). The average of NRL value on TCP/FTP (1.477) is also lower than UDP/CBR (1.676). This condition occurs because of flow control function of TCP that UDP does not have it. It causes the UDP data packets received become lower than the routing packets received.

TABLE VI. THE VALUES OF PDR OF THE SECOND SCENRIO

Nodes	Connection	PDR (%)	
		TCP	UDP
10	1	95.340	42.115
	3	98.474	18.327
	6	96.023	7.560
20	1	98.392	38.547
	3	97.448	17.659
	6	96.139	6.297
30	1	98.761	33.499
	3	96.774	14.750
	6	95.146	4.424
Average		96.944	20.686

Table 6 shows that the PDR values of the second scenario of TCP/FTP tend to be similar. The average of PDR value is about 96%. With connection oriented and flow control system of TCP, congestion condition does not give impact to TCP/FTP system.

In UDP/CBR, the PDR values change according the congestion level. When the node number is 10 nodes, the PDR values of UDP decrease from 42.115% on 1 connection, 18.327% on 3 connections until 7.560% on 6 connections. When node number is 20 connections, it becomes lower than 10 nodes, namely 38.547% on 1 connection, 17.659% on 3 connections until 6.297% on 6 connections. And it becomes lower again when the node number is 30 nodes, namely 33.499% on 1 connection, 14.750% on 3 connections until 4.424% on 6 connections. Shortly, the increasing of traffic load in congestion causes the PDR value becomes to degrade.

IV. CONCLUSIONS AND FURTHER RESEARCH

This study has shown that the increasing of node velocity causes the value of RO and NRL on TCP/FTP tend to increase. But it tends to have no influence on the value of RO and NRL of UDP/CBR. In this case, the average of RO and NRL on TCP/FTP is much higher than the average of RO and NRL on UDP/CBR. In other side, it causes the PDR value tends to degrade either on TCP/FTP and UDP/CBR. This study contributed and proved that the increasing of node velocity can degrade the performance of AODV MANET and at the same time it argued another previous research claim that the node velocity did not have influence to the performance of AODV MANET.

In the second scenario, the increasing of traffic load also causes the value of RO tends to increase, either on TCP/FTP and UDP/CBR. The value of RO on TCP/FTP is higher than the value of RO on UDP/CBR. Even in congestion condition, the value of RO on TCP can be above 1. So does the the value of NRL, the increasing of traffic load also causes the of NRL tends to increase, either on TCP/FTP and UDP/CBR. Even in congestion condition, the NRL of UDP/CBR can be higher than the NRL of TCP/FTP. In the other side, the increasing of traffic load causes the value of PDR on UDP/CBR tends to degrade. But it tends to have no influence on the PDR value of TCP/FTP. It means that the congestion condition tends to degrade only on the performance of UDP/CBR on AODV MANET. In this scenario, this study contributed to describe the performance behavior of AODV MANET in congestion condition in more detail.

Future research should explore the problems around the performance of routing protocol in MANET mathematically, in order to obtain more precise results. The enhancement of routing protocol performance is also highly recommended for future research.

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Dehumidifier Heat Pump Dryer for Corn Drying and Process Characterization

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Abstract— How to build a corn dryer that is not weather dependent yet energy efficient? And how the characteristics of corn dryer?. This research objectives are: Design and develop a dehumidifier heat pump dryer for corn drying. Observing the characteristics of drying time, temperature and humidity of drying air and consumption of drying energy. This study consists of two stages. First, design and build a dehumidifier heat-pump dryer for corn and instrumentation to monitor the drying process parameters. Second, characterizing the process of drying the corn using a dehumidifier heat-pump dryer to build a knowledge base for the corn drying. The results of the study were concluded. The lower the speed setting of blower fan, the higher the air temperature of the dehumidifier heat pump dryer. The highest drying air temperature in this study was only 53C. The lower the evaporator temperature setting, the lower the drying air humidity. The lowest drying air humidity in this study reached 19%.

Keywords—corn; dehumidifier heat pump dryer; relative humidity

I. INTRODUCTION

Corn as one of the important carbohydrate-producing food crops besides rice and wheat. As a producer of carbohydrates, corn is used for staple foods, animal feed industry, cornstarch, cooking oil, ethanol [1]. Because of that, the demand for corn continues to increase from year to year. Increased demand for corn is seen in the export-import statistics of agricultural commodities 2001-2013 issued by the Directorate General of Processing and Marketing of Agricultural Products, the Ministry of Agriculture, Republic of Indonesia[2]. Chafid [1] describes the research on corn production and forecasting for the next 5 years period of data on corn import production and exports in the outlook for agricultural commodities in the corn food sub-sector. It is projected that there will be an increase in corn production in the 2016-2019 period and a surplus in 2016. The corn production surplus is expected to decrease in 2014 due to the increasing demand for corn for the animal feed industry.

Efforts to maintain the availability of corn commodity stocks must be accompanied by efforts to maintain the quality of corn stocks. The quality of corn will be well maintained if stored in conditions of moisture content below 14% wet base according to SNI 01-3920-1995 standard [3]. The popular

traditional way to dry corn is to dry it directly in the sunshine. This method is mostly done in tropical countries [4, 5, 6]. This method is mostly done because of low cost considerations [7, 8]. But this method of drying in the sunshine also has many shortcomings, including poor quality results due to uneven drying rates [4], drying process and quality results that are very weather dependent [6], and food safety issues due to pollutants [5]. The various corn drying methods that have been done to overcome the shortcomings of sunshine drying are: using zeolite [3], microwave wave radiation [9], infrared radiation [10], and heat pump technology [11].

The drying process consumes large amounts of energy in many industries, including the food processing industry. Drying energy is needed in the process of phase change and transport of water to the vapor phase [12]. In drying using sunshine this energy is obtained for free and abundant to evaporate water [7]. But the drying process in the industry requires other energy sources from microwave radiation [9], infrared radiation [10] and heat pump technology [11]. This energy cost is not inexpensive, so technology is needed to optimize the use of drying energy. Among the technologies used are intermittent drying [13], absorbent material to absorb moisture[3]. Besides that, heat pump technology can save energy consumption by taking away wasted heat energy from the environment. Sosie [11] takes the latent heat of condensation to increase the air temperature of the dryer using a heat pump. To achieve optimal results and low costs, the drying process parameters must be monitored and controlled appropriately[12, 14].

II. OBJECTIVE AND RESEARCH METHOD

From the research background description, it can be summarized that there are important issues that must be resolved for good quality dry corn production. How to build a corn dryer that is not weather dependent yet energy efficient? How the characteristics of drying corn using a developed dryer? Based on the formulation of the problem raised in this study, the research objectives are: Design and develop a dehumidifier heat pump dryer for corn drying. Observing the characteristics of drying time, corn moisture content, temperature and humidity of drying air and consumption of drying energy. This study consists of two stages. First, design and build a dehumidifier heat-pump dryer for corn and

instrumentation to monitor the drying process parameters. Second, characterizing the process of drying the corn using a dehumidifier heat-pump dryer to build a knowledge base for the corn drying. The first phase of this research is to build a drying machine and instrumentation for dehumidifier heat pump dryer. Study of drying system design, designing system and drying machine components, and instrumentation components, procurement of drying machine components and instrumentation components, manufacturing the drying machines, developing process parameter instrumentation, and testing the drying machines. The second phase of this research is the characteristic test of corn drying process using a dehumidifier heat pump dryer. Starting from experimental design, research hypotheses, research setup preparation, research data collection, data processing and analysis of research results.

III. EXPERIMENT SETUP AND MEASUREMENT

The independent variables for the characteristic test of corn drying process using a dehumidifier heat pump dryer are:

- X1. Speed blower fan
- X2. Evaporator temperature
- X3. Drying time
- X4. Initial weight

The dependent variable for the characteristic test of corn drying process using a dehumidifier heat pump dryer are:

- Y1. Dryer air temperature
- Y2. Relative humidity of drying chamber air

Each factor of independent variables is divided into three level factors:

- X1. Speed blower fan: Low, medium, High
- X2. Evaporator temperature: 17°C, 20°C, 23°C.
- X3. Drying time: 150 minute
- X4. Initial weight: 10 kg.

Following is an experimental procedure conducted in this study.

1. Preparation of the dryer machine
2. Installation of electrical power by plugging into a power outlet and energy meter correctly.
3. Press the ON button available on the remote.
4. Setting the temperature of evaporator and blower speed fan according to the specified machine:
 - a. Direct the remote to Air Conditioner Unit
 - b. Press the mode and press the button upwards to increase the evaporator's temperature level.

- c. Press mode and press the button downwards to reduce the evaporator's temperature level.
- d. Press mode and press the button to the right to increase the level of the blower speed fan.
- e. Press mode and press the button to the left to lower the blower speed fan level.
5. Prepare the period of time of corn to be dried
6. Prepare instrumentation to monitor air temperature and humidity, do datalog acquisition.
7. Run the dryer and set the timer.
8. After the time limit is reached, turn off the dryer and unload dried corn.
9. Record the drying energy consumed
10. Weigh and record the time period to drying.
11. Save the dryer air datalog.

IV. RESULT AND DISCUSSION

The results of measurements of temperature and relative humidity of the drying air in dehumidifier heat pump dryer are shown in figure 1 through figure 9. The 'A' data series is the data of drying air before entering the drying chamber, and the 'B' data series is the data of the air leaving the drying chamber. The dehumidifier heat pump dryer is run for 150 minutes to drying 10 kg of wet corn. Air temperature and drying air humidity reach steady state after 20-30 minutes after the dryer is turned on (Table I). The fastest settling time, 20 minutes on the evaporator temperature parameter 17°C (figure 1) or the high speed fan setting parameter (figure 7). This is due to at the lowest temperature setting 17 °C, the dehumidifier heat pump dryer works at full power so that the dryer reaches steady state conditions faster. Likewise on high speed fan settings, air circulation runs faster so that it reaches steady state conditions faster. The longest settling time at the medium speed fan setting parameter with evaporator temperature 23°C (figure 6), reaches 35 minutes. This happens because the dehumidifier heat pump dryer works on the lowest power setting so it cannot immediately reach the steady state condition.

The drying air temperature leaving out of the drying chamber is always lower than the drying air temperature that enters the drying chamber (Table II). This is due to the process of evaporation of corn water content taking heat energy from the drying air. The highest average dryer air temperature is 52°C reached at the low speed fan setting (figure 1, 2, 3), and vice versa the average lowest drying air temperature 50 °C is reached at the high speed fan setting (figure 7, 8, 9). This is due to at low speed fan air circulating slower than at high speed fan settings, so that the heat transfer between the heat exchanger and the air goes better. The heat released by the heat exchanger is received by less air circulation on the low speed fan setting so that the temperature increases higher.

Table III also shows that there is an increase in drying air humidity after leaving the drying chamber. This shows that the drying air comes out carrying moisture which comes from the water content of the corn. The lowest average humidity is

reached at the lowest evaporator temperature setting of 17°C (figures 1, 4, 7), at 20% relative humidity. The highest air humidity is reached at highest evaporator temperature setting 23°C (figure 3, 6, 9) of 22% relative humidity. This happens because at the lowest evaporator temperature setting, the contact surface of the evaporator reaches below the dew point is able to produce the most condensate compared to the higher temperature setting, 20°C or 23°C. So that with more and more moisture vapor condensate is formed, the dryer air humidity decreases.

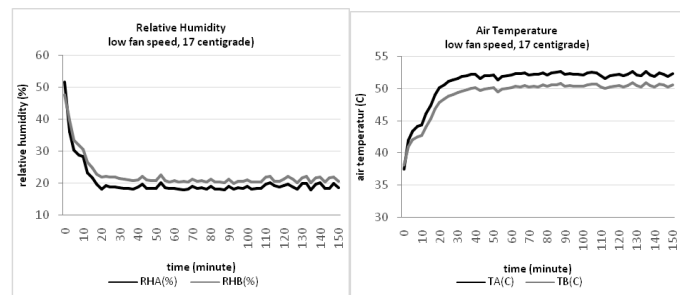


Fig. 1. Dryer air temperature and relative humidity, low fan speed, 17°C.

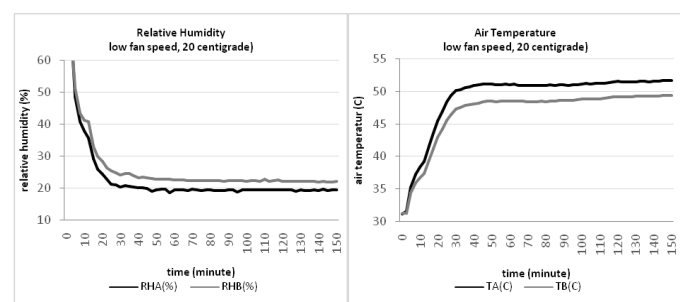


Fig. 2. Dryer air temperature and relative humidity, low fan speed, 20°C.

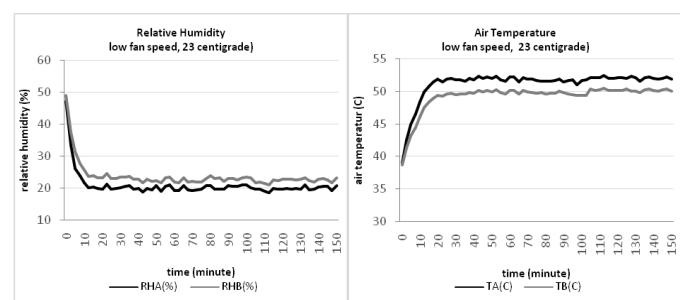


Fig. 3. Dryer air temperature and relative humidity, low fan speed, 23°C.

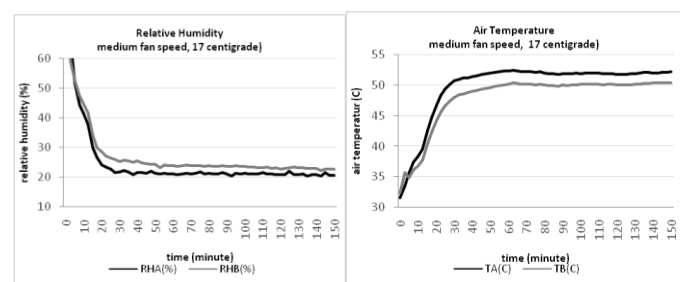


Fig. 4. Dryer air temperature and relative humidity, medium fan speed, 17°C.

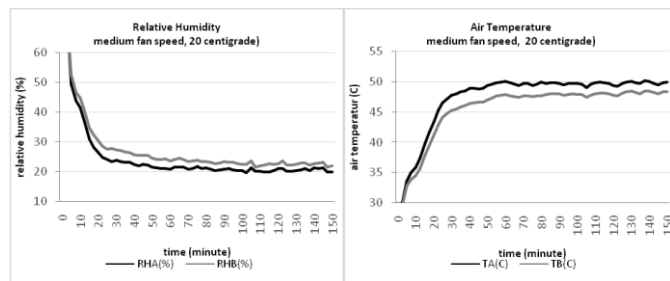


Fig. 5. Dryer air temperature and relative humidity, medium fan speed, 20°C.

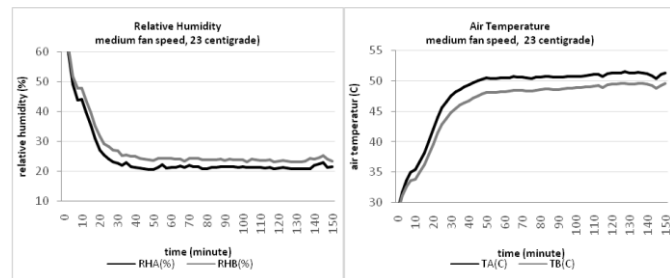


Fig. 6. Dryer air temperature and relative humidity, medium fan speed, 23°C.

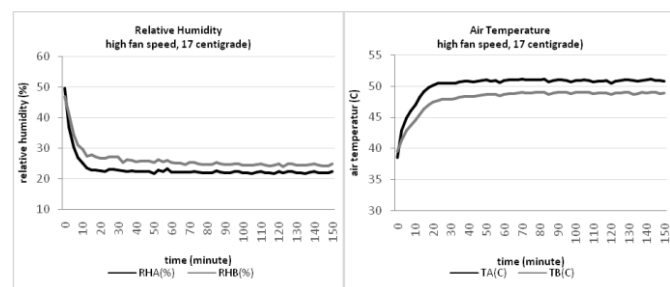


Fig. 7. Dryer air temperature and relative humidity, high fan speed, 17°C.

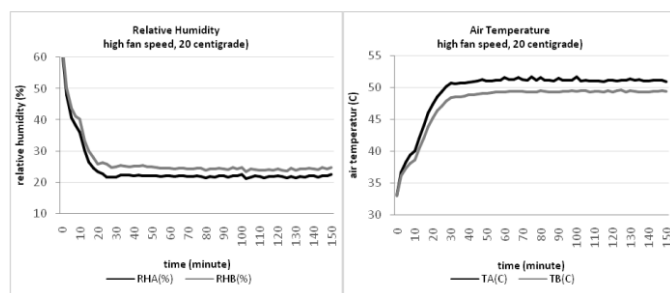


Fig. 8. Dryer air temperature and relative humidity, high fan speed, 20°C.

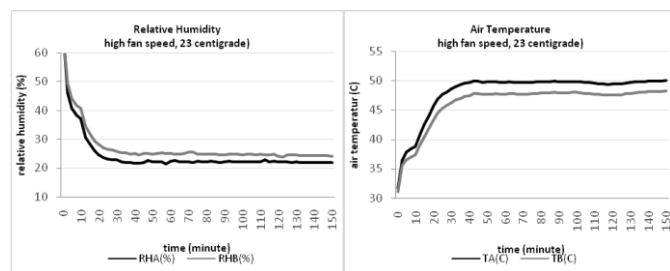


Fig. 9. Dryer air temperature and relative humidity, high fan speed, 23°C.

TABLE I. SETLING TIME TO STEADY STATE

setting time (minute)		Fan Speed		
		<i>low</i>	<i>med</i>	<i>high</i>
Evap Temp (centigrade)	17	20	25	20
	20	25	30	25
	23	30	35	30

TABLE II. MAXIMUM INLET – OUTLET AIR TEMPERATUR

max inlet air temp(°C)		Fan Speed		
		<i>low</i>	<i>med</i>	<i>high</i>
Evap Temp (centigrade)	17	53	52	51
	20	52	51	51
	23	52	51	51

max outlet air temp(°C)		Fan Speed		
		<i>low</i>	<i>med</i>	<i>high</i>
Evap Temp (centigrade)	17	51	50	49
	20	50	49	49
	23	50	49	49

TABLE III. MINIMUM INLET – OUTLET AIR HUMIDITY

max inlet air humidity		Fan Speed		
		<i>low</i>	<i>med</i>	<i>high</i>
Evap Temp (centigrade)	17	19%	20%	21%
	20	20%	20%	21%
	23	20%	21%	21%

max outlet air humidity		Fan Speed		
		<i>low</i>	<i>med</i>	<i>high</i>
Evap Temp (centigrade)	17	21%	21%	23%
	20	22%	21%	23%
	23	22%	23%	23%

V. CONCLUSION

Based on the observations of the study concluded that. The lower the speed setting of the fan blower, the higher the air temperature of the dryer. The highest drying air temperature in this study was only 53°C. The lower the evaporator temperature setting, the lower the drying air humidity. The lowest drying air humidity in this study reached 19%.

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Implementation 4 – DoF Arm Robot Object Sorting Controlled Based On Color Using Inverse Kinematics Algorithm

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Abstract— Arm manipulator is one type of robot that is widely applied in the industrial world. Robots of this type are commonly used to help people in the hard work, dangerous or repetitive work. The needs of industrial machine in Indonesia have been increasing based on industrial development that has been increasing too in Indonesia. Some kind of industry producing a different kind of package for one product. So it needs a machine that can clarify the product based on the packaging. The purpose of this study was to design a mechanical configuration model consisting of 4 DOF arm robots and conveyors, which are used as objects separating objects based on color. A 4 DOF arm manipulator prototype designed as sorting object by color in this research. The arm manipulator's prototype using inverse kinematics motion in determining the position of the sorted object transfer. Photodiode detector is used in order to distinguish the object based on its colors. The output of this research is to produce a 4 DOF arm manipulator prototype that can move and sort object by its color. From the experimental results of tests performed with the initial position of the robot is able to move the object from the initial coordinates to the coordinates that have been determined according to the color of the object point, the time it took an average of 9.71 s with an average error of 24.5%. In testing the sensor TCS3200 almost perfect but still a bit error due to the influence of outside light. To test the robot was very good overall level of success achieved has been 86.66%. Based on the results of testing that has been done by the robot arm 4 DOF inverse kinematic methods and trajectory planning is very effective in making the process move stuff. With the implementation of the research, it is expected that an alternative development model for industrial control system technology will be achieved by integrating arm robots and conveyor movements so that this can improve system efficiency.

Keywords—arm robot; inverse kinematics; object sorting;
Introduction

I. INTRODUCTION

In the era of globalization, market competition becomes tight. The main reason for using robots in the world industry is for a fee issued. Besides that, robots can also work faster, accurate, durable and more flexible. Robots are created very

diverse, such as legged robots, wheeled robots and robots that move in all directions there are even robots that resemble humans even though only certain parts, such as heads, feet or arms. The arm manipulator robot that has been widely applied in industrial fields, such as welding robots, robot handling, punching robots, robotic machine tools, etc. [1]. Robot arm is not only used in industry, but also used in the field of research and health. An example is the robot arm inside industry is a welding robot from Fanuc Industry and painting robots manufactured by Kawasaki. One of the forms of robot arm that is often used is the arm anthropomorphic robot model. This robotic arm has flexibility in operational mode in 3-dimensional space, so it is suitable for application in most industrial robots [2][3].

In general, the structure of the robot arm consists of arms and wrists. The arm part is composed of a series of links, with one link configuration with the other link connected with the joint component. With the joint connecting the two links, the joint will form a degree of freedom. While at the end of the robot arm is equipped with end-effectors with a gripper model that is used to perform a particular purpose [4]. In another study there was the development of an arm robot control system, in the form of a dual arm robot controller [10].

Many studies explain the use of arm robots in industry. Some studies use manual control as a movement instruction for robot arm [5]. While other studies, color codes are used for the selection process. In another study, the robot arm used was in the form of a 3 DOF configuration (Degree of freedom) [6]. In this study the robot arm was developed using the 4 DOF (Degree of freedom) model. In the sorting process, 4 different object colors are used: red, green, blue and yellow.

In the next process, automatic control based on inverse kinematic method is used to control the movement of arm robots in order to move objects to a place that match the object's color. the purpose of this study was to design a mechanical configuration model consisting of 4 DOF arm robots and conveyors, which are used as objects separating objects based on color.

In this case a mechanical model scheme is designed that configures two main components, consisting of arm robots that move with kinematic inverse algorithms and conveyors as object detection drive systems. A color sensor with type TCS3200 is used as an object color detector. The purpose of the mechanical configuration in this study is as a new form in the development of a control model in industrial robotics technology that combines robotic arm control and conveyor movement control. The combination of synchronous control between 4 DOF arm robots and conveyors in the object sorting process is expected to improve the efficiency and performance of the system

II. DESIGN OF THE CONTROL SYSTEM

The Robot DO manipulator 4 DOF designed in this study is a prototype scale. This robot is designed to be able to sort items by color and move according to the place. For determine the position of the end-effectors movement of the robot is used geometry inverse kinematics motion method [7].

A. Design Of Arm Robot For Color – Based Object Sorting

The mechanical structure of the robot arm consists of several parts and the most important part is the servo motor. Servo motors used in the robot arm are hitech with type hs 422, which produces a maximum torque of 3 kg. The total number of servo motors used for robotic mechanics is 5 units, consisting of 4 hitech motor types hs 422 and 1 servo type pro mg tower 90s. This servo motor is arranged with a combination of 3 servo motors used as joints and one servo motor is used as a robot base. As for the servo motor with towerpro type, it is used as a gripper, while the aim is to reduce the load on the robot arm. For more details, see Fig. 1.

From Fig. 1 the robot arm mechanical system is shown which consists of the following parts:

- Base is the basic part of the robot arm and the place of the servo motor base.
- The base of the robot arm, this part is the base board of the robot arm made of wooden boards.
- Servo base motor, this motor is used as a robot driving the bottom so that it can move in 3-dimensional direction.
- Link 1, is the first part of the arm with a horizontal static position.
- Servo link 2 motor, is a motor that functions to move arm part 2.
- Link 2, is arm part 2.
- Servo motor link 3, is a servo motor that functions to move arm part 3.
- Link 3, is a robot arm part 3.

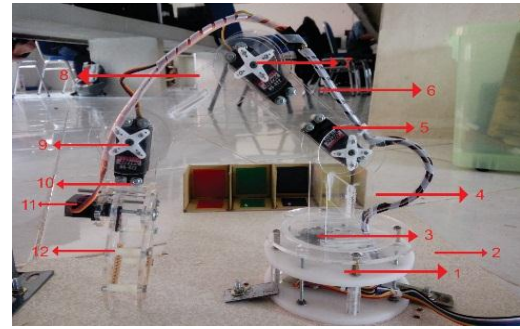


Fig. 1. Mechanical Structure Of 4 – DoF Arm Robot

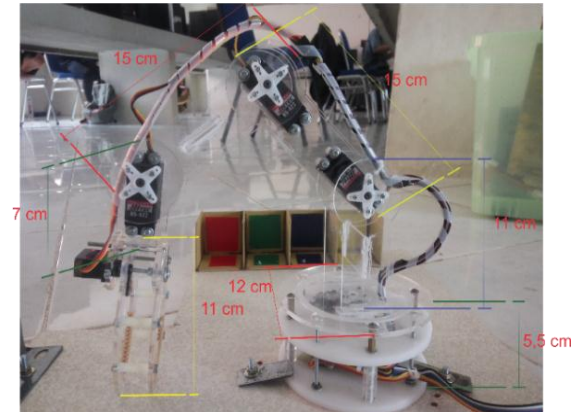


Fig. 2. Dimension Configuration Of 4 – DoF Arm Robot

- Servo motor link 4, is a servo motor that functions to move the robot arm part 4.
- Link 4, is the robot arm part 4
- Gripper servo motor, this motor is used to move the gripper in the open or close process.
- Gripper (clamp), this section is useful as a clamp object when the object will be moved to another place

The size of the robot mechanics is adjusted to the torque characteristics of the servo motor. So that the mechanical design is designed not to exceed 3 kg. A detailed measure of the mechanical structure of the robot arm is shown in Fig. 2 below.

The basic material of this robot arm uses acrylic with a thickness of 2 mm, the purpose of using 2 mm acrylic is to keep the robot light but still strong. For the design process each part of the robot uses Corel Draw X5 Software.

B. Hardware Connection Diagram

In this research, a 4-dof arm robot has been designed to move objects and place objects automatically in a place with a color code on an object. Fig. 3 shows the block process diagram of the system based on the design of the robot arm sorting object;

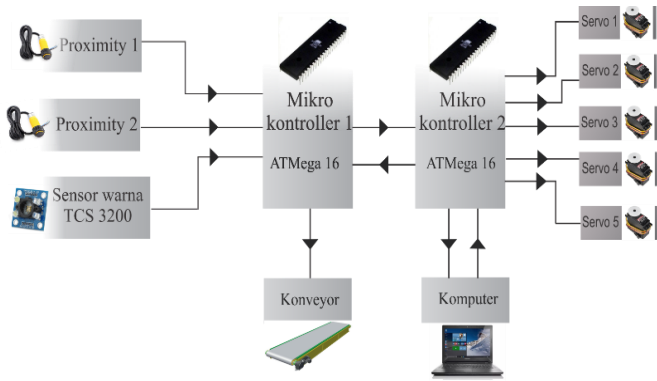


Fig. 3. System Diagram Block Of 4 DoF Arm Robot

C. Hardware Implementation

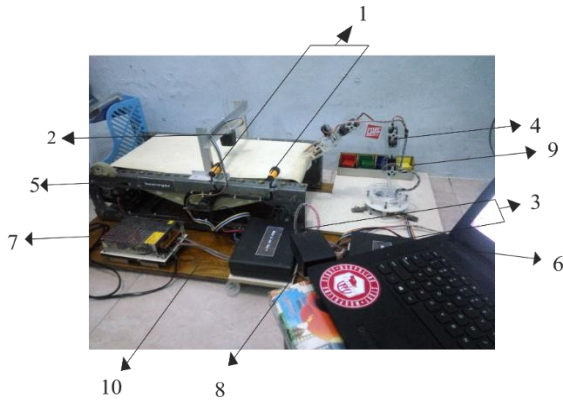


Fig. 4. Implementation of 4 DoF Arm Robot

Designing a robot arm 4 DOF object sorting is done using a servo motor actuator as the main component. The sensor used for object color detection is TCS3200. While the controller used is the ATmega16 microcontroller which functions to read sensor data, process algorithms, communicate with computers through interfaces and adjust the servo controller position changes. Robot 4 DOF prototype arm designed on this research can be seen as Fig. 4.

The whole system is shown in Fig. 4 which consists of the following sections:

1. Proximity 1 and Proximity 2, this component is used as a sensor for detecting objects. Proximity 1 for first position and proximity 2 for position 2.
2. The TCS 3200 sensor, this section functions as the initialization of the object.
3. The first microcontroller and the second microcontroller, there are two microcontrollers in this sorting system, the first microcontroller is used as a control of the entire system on the conveyor and the second microcontroller is used as a robot arm control.
4. 4 DOF arm robot, is a robot that is used as a moving object from the conveyor to the object's place.
5. Conveyors, these conveyors are used as a place to initialize objects with a moving state

6. Laptop is parts that are used as a place to monitor the GUI from the work system.
7. DC Power Supply, this section is used as the overall power supply system.
8. USB TTL, this part is used as communication between laptop and hardware.
9. Place of sorted object is the place of objects placed that has been splitted by its color.

D. Software Implementation

The interface application on the computer is designed to perform various tests and control the 4 DOF arm robot. Experiments that can be done on robot arm by using interfaces namely serial communication testing, servo motor testing, and robot motion kinematics testing.

In addition, the application interface that is designed is also useful to control the robot arm, which is as the provider of the command to start, stop, and provide data transfer locations. Fig. 5 shows the application display interface designed in this research.

III. INVERSE KINEMATICS ALGORITHM

By looking at the geometry model in Fig. 6, the kinematic inverse for the arm robot can be determined in order to define the value of $\theta_1, \theta_2, \theta_3$ and θ_4 . In determining the value of each θ the value of the x, y, z coordinates and the length of the link (L1, L2) must be known. The equation used to solve this problem is [8]:

$$\theta_1 = (a \tan^2 (y, x)) \quad (1)$$

The input used in equation (1) is the value of the x and y coordinates, which are the target coordinates, then the value θ_1 will be obtained. After θ_1 is obtained then determine the value of θ_2, θ_3 and θ_4 . In defining the third value θ it is necessary to get the values of a and b first, and to be able to determine the values of a and b, it is done by finding the value of the arm length (L)

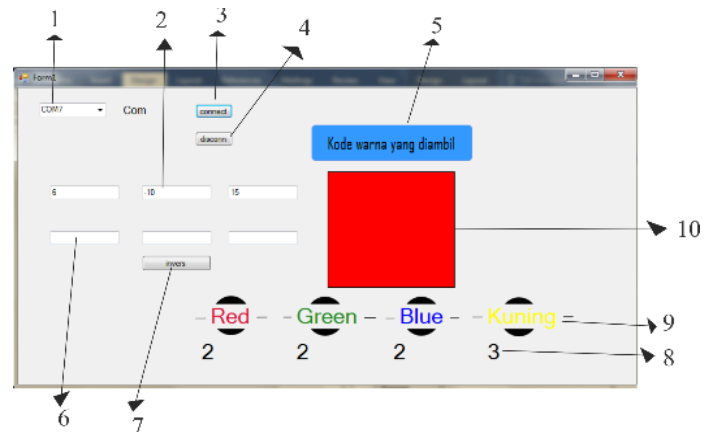


Fig. 5. Implementation of Interface Application Of 4 DoF Arm Robot

The formula for finding the length of the Arm, L, a and b can be obtained using equations 2 to 5

$$\text{ArmLength} = \sqrt{((x * x) - (y * y))} \quad (2)$$

$$L = \sqrt{((\text{ArmLength} \times \text{ArmLength}) - (z * z))} \quad (3)$$

$$a = \frac{((L * L) - (l_1 * l_1) - (l_2 * l_2))}{2 * l_1} \quad (4)$$

After the variable values of a and b are obtained, the next step is to enter the value into the formula θ_3 , using the following equation 6:

$$\theta_3 = a \tan^2(b, a) \times \frac{180}{3.14} \quad (5)$$

After finding the value θ_3 then look for the value θ_2 by using the following equation 7:

$$\theta_2 = (a \tan^2(b, (l_1 + a))) + (a \tan^2(z, \text{arm_length})) \quad (6)$$

After the values of θ_3 and θ_2 are obtained, then determine the value of θ_4 by using equation 8:

$$\theta_4 = (\theta_3 + \theta_2) \times (-1) \quad (7)$$

The following is a description of each variable from the equations used:

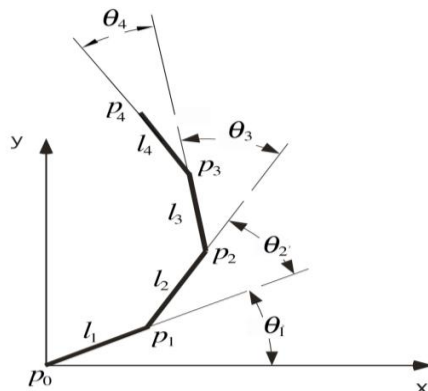


Fig. 6. Geometry Model Of 4 DoF Arm Robot

TABLE I. D – H PARAMETER OF 4 DOF ARM ROBOT

Join	Link Lenght (a1)	Link offset (d1)	Joint angle (θi)	Twist angle (αi)
1	0	15cm	θ1	90°
2	10 cm	0	θ2	0
3	10cm	0	θ3	0
4	6cm	0	θ4	0

- θ_1 = Servo angle 1
- θ_2 = Servo angle 2
- θ_3 = Servo angle 3
- θ_4 = Servo angle 4

- L = overall arm length
- y = y-axis coordinate
- x = x-axis coordinate
- z = z axis coordinate
- Arm = arm length per joint

To solve the equation in kinematic inverse algorithm, the D-H parameter configuration is used as table 1 below:

IV. SIMULATION AND ANALYSIS OF THE SYSTEM

The experiment was carried out to determine the conditions and results of the prototype robot arm designed. Testing was also conducted to determine the ability of the arm robot to sort and move objects according to their color.

A. Color Sensor Testing

Color sensor testing is done to determine the output voltage of each color. Table 2 is the result of dividing the filter reference range for each color category. The colors used are red, green, yellow and blue.

B. Kinematics Inverse Testing

Testing of inverse kinematics is done to test the precision of the robot's arm to move to a certain position and to determine the change in angle of each joint. In this inverse kinematics test contains testing of X axis variations, Y axis variations, and variations of Z axis[9].

Kinematic inverse testing is done by setting the initial coordinates and target coordinates of the arm robot. Then the last position of the robot will be calculated as the final position. The difference in value between the target position and the initial position is calculated as a position error. Kinematic inverse test results are shown in table 3. Based on data shown in table 3, the error value can be calculated on each axis. The average time taken for each test was 9.73s, for the target time of 10s, so that the average error time achieved was 24.5%

C. Object Sorting Test

The sorting test is carried out to determine the capabilities of this robot arm as robots designed to sort items, so this test needs to be done to find out this ability.

In this test the whole process is complete, starting from placing objects in the specified position on the conveyor, until the objects are grouped according to their color. Illustration of the testing process shown in Fig. 7.

TABLE II. COLOR SENSOR TESTING RESULT

No	Object Color	Range Filter Reference (Hz)
1	Blue	2000 > value > 1400
2	Red	3000 > value > 2000
3	Green	4000 > value > 3000
4	Yellow	Value > 4000

TABLE III. INVERSE KINEMATICS TESTING RESULT

Mot ion	Initial coordinate	Target Coordinate	Final Coordinate	Average Time
1	3, 0, 30	6, -10, 15	6, -12, 15	09,80
2	3, 0, 30	3, -10, 15	4, -11, 15	09,71
3	3, 0, 30	-2, -10, 15	-2, -11, 15	09,73
4	3, 0, 30	-5, -10, 15	-5, -10, 15	09,71
Average Time				9,73

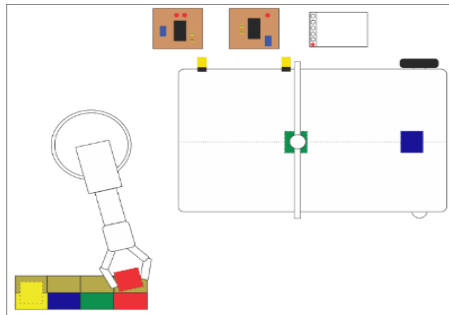


Fig. 7. Work Illustration Of 4 DoF Arm Robot

From Fig. 7 it can be seen that the arm robot moves towards the coordinates based on kinematic inverse algorithm to do the sorting process determined according to the results of the color sensor data. The position of the sorting results is distinguished by the color of each object. Each color position is given a different initial label. for the red color label 1 is given, for green is labeled 2, while for blue is label 3 and for yellow is labeled 4. In table 4 shows the results of testing the whole robot by detecting the object colors and the results of the sorting process.

From table 4 it can be seen that the position of the coordinate points reached is correct but still experiencing some error. The final coordinate point is determined from the initialization of the TCS3200 color sensor, so if the sensor is not right in the color initialization process, then the coordinated target will also produce an error in the sorting process.

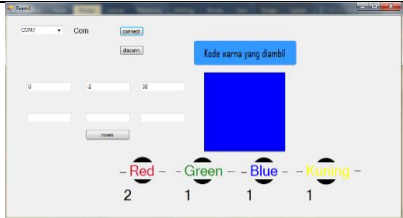


TABLE IV. OBJECT SORTING RESULT

Sam- ple	Color Object	Initial coordinat			Final Coordinat			Sorting	Result
		x	y	z	x	y	z		
1	Red	3	0	30	6	-10	15	1	Success
2	Green	3	0	30	3	-10	15	2	Success
3	Yellow	3	0	30	-5	-10	15	4	Success
4	Blue	3	0	30	-2	-10	15	3	Success
5	Red	3	0	30	6	-10	15	1	Success
6	Blue	3	0	30	-2	-10	15	3	Success
7	Yellow	3	0	30	-5	-10	15	4	Success
8	Green	3	0	30	3	-10	15	2	Success
9	Yellow	3	0	30	-5	-10	15	4	Success
10	Red	3	0	30	6	-10	15	1	Success
11	Green	3	0	30	3	-10	15	2	Success
12	Blue	3	0	30	-2	-10	15	3	Failed
13	Green	3	0	30	3	-10	15	2	Failed
14	Yellow	3	0	30	-5	-10	15	4	Success
15	Blue	3	0	30	-2	-10	15	3	Success
Success percentage									86,6%

Table 5 shows the results of the interface process between the data generated by the hardware and the GUI application. Tests are carried out to see the color equation of the object given with the reading displayed on the color code interface. In addition, it also sees the number of objects that have been moved by the robot arm. For the results of the gui test can be seen in table V.

TABLE V. GUI APPLICATION TESTING RESULT

Sample	Object Color	GUI Testing Result
1	Red	
2	Green	
3	Yellow	
4	Blue	
5	Red	

Sample	Object Color	GUI Testing Result
6	Blue	
7	Yellow	
8	Green	
9	Yellow	
10	Red	

From table 5, it can be seen that the initialization and detection process of the TCS 3200 sensor is almost perfect but there is still an error for reading blue and green codes. This happened because the TCS 3200 sensor was very susceptible to external light. For the counter results from the process of moving objects to the place is still not perfect, this is because the initialization is not correct so the calculation of the counter will follow the color code taken

V. CONCLUSION

Based on the results of the design, implementation and testing of the system that has been made, the following conclusions can be drawn:

2D using the kinematic inverse method and trajectory planning robot arm can move according to the coordinates x y and z which are specified as the end points.

From the testing time of the robot's place in the process of placing objects to an average time required of 9,73 s. In the overall test, it is known that the arm robot has a success rate of 86.6% in the process of sorting objects based on color.

The synchronous control system design model between robot arm and conveyor that has been implemented in this research, has shown significant results so that it can become an alternative control system that can be implemented in the applied industrial sector

As a model for further research development, the camera can be integrated as a color detector with the aim of increasing speed and accuracy in detecting object colors, so that it is expected to increase the efficiency and effectiveness of the system in achieving its function.

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Match Between Students' Anthropometry and Furniture Dimensions in the Library Reading Area at University of Trunojoyo Madura

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Abstract—The compatibility between the dimensions of furniture and users' body is crucial in keeping the users' performance. The objective of this study is to identify whether the furniture dimensions in the library reading area at University of Trunojoyo Madura (UTM) are appropriate/inappropriate to the students' anthropometry and to find a recommendation for appropriate dimensions for designing library furniture. The current study was begun by measuring the furniture dimensions and the students' anthropometry. The evaluation was done by following methods adapted from previous studies that determine the furniture dimensions based on the anthropometric and ergonomic principles. The compatibility criterion was determined by considering the relationship between the furniture dimensions, the students' anthropometry and assumption(s) regarding what they wear and their behaviors during they are in the reading area. The finding of this study showed the mismatch between the students' anthropometry participated in the measurements and the furniture dimensions. Another important finding was that this study provided/offered a recommendation that was suitable dimensions for designing library furniture at UTM.

Keywords—furniture dimensions; anthropometry; chair; desk; bookcase

I. INTRODUCTION

Students spend their time in a sitting position to do their lecture work in the classroom, library, studying room and some other possible places. Considering the duration spent in the sitting position, the match between the seat and the students' anthropometry is very important. This is because the mismatch between the furniture dimensions and the user anthropometry could potentially lead to negative implication such as learning comfort [1], fatigue occurrence [2], and musculoskeletal disorders [3][4][5].

Few approaches have been developed in evaluating the furniture dimensions and the users' anthropometry. One of the evaluation methods is comparing the users' anthropometry and the relevant furniture dimensions. A general principle in designing a product, i.e. (1) design for average dimensions, (2) design for extreme dimensions and (3) design for a specific range dimension, was also possible to use in a furniture evaluation[6]. In addition, it also crucial to consider the users'

mental characteristics and behaviors in using the furniture. Each user has a specific need and obstacle when he/she was sitting on a chair. For example, individuals with upper back and neck problem probably like chair with the upper edge of the backrest tapers and narrows in order that they could get more freedom of motion. Overall, an approach used by [7] is considerable and practicable. The proposed equations that were developed and adapted from previous relevant studies can help other researchers in evaluating the furniture design.

Students are a unique occupational group since their stage of development influences some aspects of their human-machine-environment system [4]. Regarding the furniture design for the students, many studies have been conducted to evaluate a potential incompatibility between the dimensions of furniture and students' body [8][9].

Few studies performed in various university/college of different country confirmed the incompatibility between the dimensions of furniture and the students' body [9] [10][11]. Similar findings also occurred in few observations on the school furniture [12][13][14][15]. Considering the lack of anthropometric data for the Indonesian population and the existent of various ethnics in this nation, findings of those studies were also possible to occur in Indonesia. Specifically, since there was no detail information about the furniture dimensions and their relevant anthropometry of students at UTM, it was possible to say that the current study is very important to solve the question whether the furniture in the library reading area match to the students' anthropometry or not.

Drawing from the background above, the objective of this study is to analyze the compatibility between the furniture dimensions and the students' body. Considering the case in the library reading area at the University of Trunojoyo Madura, it specifically aims to find a recommendation for appropriate dimensions for designing library furniture.

II. METHODS

In order to address the research problem defined above, this study was conducted in a few steps. First, an observation was done to identify the furniture types available in the library reading area at UTM. The second step was measuring the

anthropometry of students which was relevant to furniture dimensions. The third step was comparing the dimension of chair, desk, and bookcase to the relevant students' anthropometry. The last step was choosing and modifying equations used to determine the suitable furniture design from the ergonomic perspective.

Four types of chair and two types of desk available in the library reading area were measured. A type of bookcase was also observed and compared to the relevant student anthropometry.

Students who frequently come and occupy the library reading area were recruited to participate in this study voluntarily. There are no specific requirements for the students to participate in this study, except they must have a normal body stature and frequently come to the library reading area.

Furniture dimensions included in the measurement were selected by considering their relationship with the relevant students' body dimensions (TABLE I). The measurements of all dimensions on the furniture and the students' body were done using a measuring tape.

The furniture dimensions are defined as follow:

- Seat plane height (SPH): the distance measured from the seat plane to the floor
- Desk height (DH): the distance measured from the top of the desk to the floor
- Upper shelf height (USH): the distance measured from the upper shelf plane to the floor.

TABLE I. FURNITURE DIMENSIONS AND RELEVANT USERS' BODY DIMENSIONS

Furniture	Furniture Dimension	Body dimension
Chairs	Seat plane height (SPH)	Popliteal height (PH)
	Seat plane depth (SPD)	Buttock–popliteal length (BPL)
	Seat plane width (SPW)	Hip width (HW)
Desks	Desk height (DH)	Elbow height (sitting) (EHS)
Bookcases	Upper shelf height (USH)	Vertical grip reach (VGR)

^a. Adapted from [7]

Four body dimensions and their definitions were adopted from [7], namely:

- Stature (S): defined as the body height, the distance measured from the top of head to the floor and taken with the subject in the standing posture with looping straight ahead (Frankfort plane).
- Popliteal Height (PH): the distance between the floor or footrest and the back surface of the knee (popliteal surface), measured with 90° knee flexion.
- Buttock-Popliteal Length (BPL): the distance measured from the back surface of the buttock to the popliteal surface and taken with a 90° angle of knee flexion.

- Hip Width (HW): the distance measured from the outer side of the left hip to the outer side of the right hip in the sitting position.

Three other dimensions were defined as follow:

- Elbow Height (sitting) (EHS): the distance measured from the lower point of the elbow tip (olecranon) to the subject's seated plane, measured with a 90° angle elbow flexion.
- Lumbar Height (sitting) (LHS): the distance between the highest point of the lumbar to the subject's seated plane.
- Vertical Grip Reach (VGR): the maximum vertical distance between the floor and the hand, measured with the subject standing upright and raising his hand in a gripping position.



Fig. 1. Types of chairs and desks analyzed.

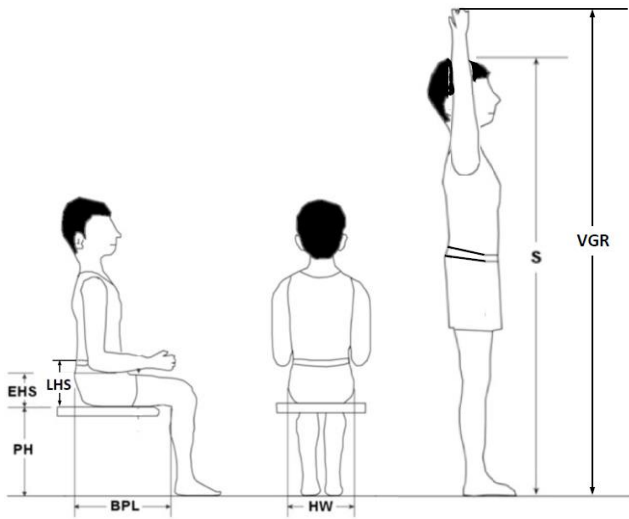


Fig. 2. Body dimensions measured in the current study (Adapted from [2]).

The evaluation was done by following methods proposed by [2] that determine the furniture dimensions based on the anthropometric and ergonomic theories. The compatibility criterion was determined by considering the relationship between the furniture dimensions, the students' anthropometry and assumption(s) regarding the students wears and behaviors during they are in the reading area. Accordingly, six equations proposed by [7] and [16] were applied in the analyses. In addition, an equation was developed to represent the relationship between the USH and the VGR.

A. Seat plane height vs. Popliteal height

Equation (1) developed by considering an evidence showing that SPH should be lower than the PH, their difference should not be more than 4 centimeters. Since it is assumed that all students wear their shoes in the reading area, the shoe sole thickness of 3 centimeters was added in this equation [7]. To accommodate more users, the 5th percentile of the PH should be considered in the design.

$$(PH+3) \cos 30^\circ \leq SPH \leq (PH+3) \cos 5^\circ \quad (1)$$

B. Seat plane (depth) vs. Buttock-popliteal length

Numerous studies have recommended that the SPD should be designed for the 5th percentiles of BPL distribution [4]. Besides, the SPD should be longer than the BPL in order that it is possible to support the thigh well. The match criterion was defined as (2) [12].

$$0.8 \text{ BPL} \leq SPD \leq 0.95 \text{ BPL} \quad (2)$$

C. Seat plane width vs. Hip width

The SPW should be designed wider than the HW in order that users can sit on the chair comfortably [6]. It must consider the 95th percentile, the largest hip width.

$$SPW > HW \quad (3)$$

D. Lower edge of the backrest vs. Lumbar height (sitting)

The LEB should be designed lower than the LHS in order that the backrest can support the back of the user properly [6]. It is possible to consider the 5th percentile, the smallest lumbar height (sitting).

$$LEB \leq LHS \quad (4)$$

E. Desk height vs. Elbow height

The desktop should be designed parallel with the elbow. Other recommendation showed that the DH should be 3-5 cm higher than the EH [3][4]. Since the DH was a distance between the desktop and the floor, in this study the DH was determined by using (5).

$$EHS+PH+3 \leq DH \leq EHS+PH+8 \quad (5)$$

F. Upper shelf height vs. Vertical grip reach

The USH was determined with an assumption that the book size is 30 cm high. In order that the students could reach dan take the desired book easily, the USH should be equal to or lower than the VGR.

$$USH \leq VGR - 30 \quad (6)$$

III. RESULTS AND DISCUSSION

As mentioned in Section II, firstly this study measured the furniture dimensions in the reading area of the main library at the University of Trunojoyo Madura. It then compares them to the students' anthropometry. Seventy-seven students (47 females) aged in the range of 18 and 24 years old involved in the measurement. The furniture dimensions and the students' anthropometric data were described below.

A. Furniture dimensions

There are four types of chairs, two types of desks and a type of bookcase in the library reading area at UTM. The dimensions of the chairs were varied, as shown in TABLE II. It also possible to see the relevant desks and bookcase dimensions in TABLE III.

TABLE II. CHAIR DIMENSIONS

No	Dimension	Measure (mm)			
		Chair 1	Chair 2	Chair 3	Chair 4
1	SPH	44	42	47	47
2	SPD	48	38	52	44
3	SPW	46	48	50	41
4	LEB	28	17	28	8

TABLE III. DESK AND BOOKCASE DIMENSIONS

No.	Dimension	Measure (mm)
1	DH-1	68
2	DH-2	70
3	USH	165

B. Students' body dimensions

The descriptive statistics of the six body dimensions of students participated in the measurements are indicated in TABLE IV.

TABLE IV. SELECTED ANTHROPOMETRY RELEVANT TO FURNITURE DIMENSIONS

No	Dimension	Mean (SD) (mm)	5%tile (mm)	50%tile (mm)	95%tile (mm)
1	PH	42.6 (2.7)	38,0	43,0	46,2
2	BPL	45.9 (3.7)	40,0	45,0	51,2
3	HW	33.9 (4.1)	30,0	33,0	42,2
4	LHS	22.9 (3.3)	20,0	23,0	25,0
5	EHS	26.1 (3.3)	21,0	26,0	32,0
6	VGR	192.8 (10.8)	172,6	193,0	210,2

C. Incompatibility between the body measures and the furniture dimensions

This comparison was done between the present furniture dimensions (TABLE II and III) and the students' body dimensions (TABLE IV). The compatibilities/incompatibilities between the corresponding dimensions were presented below.

Seat plane height is the most important dimension in designing a chair [7]. The result of analyses showed that all of the chairs were too high for 6.5% of students. Chair 3 and chair 4 were only appropriate for 20.1% of the students. Chair 1 is appropriate for 66.2% of the students involved in this study. Most of the students (74%) are possible to use Chair 2 comfortably. From the SPH perspective, it should be noted that chair 3 and chair 4 too high.

Comparison of seat plane depth between the anthropometric measures and their relevant chair dimensions showed that chair 2 was only possible for 7.8% of the students. The current study found that 64.9% of the students can use chair 4. It should be emphasized that 11.7% of the students are inappropriate with all chairs since the SPD is shorter than the relevant anthropometric dimension. It means the students' thigh was not supported adequately during they were sitting on the chair [6].

The result of this study also found all students are possible to use all chairs except chair 4. The SPW of chair 4 is inappropriate for 7.8% of students participated in the current study since their HW are larger than the SPW. In general, regarding the SPW, most of the students are possible to sit on the chair comfortably.

Desk height which also plays an important role in keeping the students' comfort was appropriate for 90% of the students. The desks 1 (DH-1) is too high for 5% of the students, while the desk 2 (DH-2) is too high for 10% of the students. The higher desk will make the students raising up their upper arm too much, and it can lead to some musculoskeletal disorders [6].

Considering the USH and the VGR, this study found that the USH is too high for 48% of the students. Assuming the book dimension is 30 cm high, 52% of the students can take a book on the bookcase easily. The first group of the students have a lower grip reach than the second group and would be possibly difficult to reach a book on the shelf.

D. Recommended furniture dimensions

The results of this study showed that generally the furniture dimensions do not match with the anthropometry of students participated in the current study. Although the number of students included in the measurements is too small, the results are possible to describe a fact that the recommended dimensions are needed for designing the library furniture. TABLE V shows the recommended dimensions that are able to consider in the design. This recommendation was based on the anthropometric data and the relevant equations in Section II.

TABLE V. RECOMMENDED DIMENSIONS FOR THE LIBRARY FURNITURE

No.	Dimension	Measure (mm)
1	SPH	35.5 – 40.8
2	SPD	32.0 – 38.0
3	SPW	> 42.2
4	LEB	< 20.0
5	DH	56.6 – 64.8
6	USH	< 142.6

IV. CONCLUSION

This study is aimed to analyze the compatibility between the students' body and the furniture in the reading area at the University of Trunojoyo Madura and to find a recommendation for appropriate dimensions for designing library furniture. In general, this study found the mismatch between the students' anthropometry participated in the measurements and the furniture dimensions. Although the number of students participated in this study is too small, it is possible to describe a need for the recommended dimensions in designing the library furniture at UTM. This study also provided a recommendation that was suitable dimensions for designing library furniture at UTM.

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Effect of Tower Construction Analysis Against Reliability Level of SUTET 500kV to Lightning Strike

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Abstract — The Extra High Voltage Air Line (SUTET) is a transmission line conductor with a voltage of 500kV which aims to deliver electrical energy from the plant to the load center, so that electrical energy can be efficiently discharged. The gap between the distant towers and the different tower construction causes the transmission channel's insignificance. Unreliable tower lines can cause channel outages and damage to existing equipment in the tower. It is necessary to construct effective and efficient transmission line tower types because of the expensive cost of repair and maintenance. So that, the transmission line performance can work reliably. Furthermore, software is needed to analyze the effect of tower construction on the reliability level of SUTET 500kV to the lightning strike using the waves running method. The software existence can be used to calculate the lightning disturbance that occurs in the tower with various types of construction in Indonesia. Also, this research results contribute to the continuity of electricity system services in Indonesia.

Keywords— electrical system; lightning strike; Extra High Voltage Air Line component;

I. INTRODUCTION

Transmission towers have the very important role in the process of distributing electrical energy from one place to another. This is due to the increasingly modern and sophisticated era so that the need for increased electrical energy in the industrial sector or the needs of society at this time. The increasing need for electrical energy must be followed by a high quality electrical energy system and has a high reliability, the principle in the transmission of electrical energy is both safe and economical. With the transmission tower, it is necessary to construct a specific transmission tower so that the need to distribute electrical energy is not hampered due to the damage of the transmission tower[1].

Disturbances that occur in the transmission tower construction one of them caused by lightning strikes. The occurrence of such damage can lead to the main components work is not in accordance with their needs resulting in failure of protection or damage to electrical construction networks that affect the transmission line. That means the reliability of a power system is determined by the ability of the system to supply

sufficient electrical energy to the consumer. So, this system must be reliable and meet the requirements to be able to reduce the sudden disruption caused by lightning strikes [2].

Transmission networks in Indonesia are more dominant using airways when compared to underground channels, because the transmission network in the manufacture more economical, easy to reach and cheap operational costs. In addition, the current electric power system is an interconnection system between one power plant and another with a purpose if either one of the power plant or transmission line is interrupted, the supply of electricity can still run. Another problem with the airways is the frequent interference with the main components. Indonesia conditions that have a tropical climate often happens lightning strikes and it is enough to make the transmission system is potentially struck by lightning. In addition, the use of airways that have different tower construction and different tower height coordinates has become one of the factors affected by lightning strikes [3-7].

Video surveillance for transmission lines, which can record the man-made destroying, foreign objects attaching to the lines, swing of the lines, conductor icing, etc. [8]

Therefore, to obtain reliable and sustainable power distribution, it is necessary to analyze the effect of tower construction on the reliability level of 500kV SUTET to the lightning strike to produce the modeling result and the software that can be applied to facilitate the design automatically.

The remainder of this paper is organized as follows: an analysis calculation of the flash interference in the tower on transmission system is presented in Section 2. In Section 3 software trial is addressed. Finally, some conclusions are shed.

II. RESEARCH METHODOLOGY

To perform this analysis calculation using the current wave method to obtain a negative reflection wave so that almost all of the flashback / backflashover occurs at the top of the phase wire so as to calculate the flash interference in the tower[3]

With case studies on Krian Substation in 2018, the main part of this method will be discussed as follows:

1. Disturbance at construction height of different tower.

To obtain the angle of ground wire protection in the construction of AA type Tower and CC type, so it can be calculated:

$$x = \sqrt{(L)^2 + (H)^2} \quad (1)$$

$$\sin \theta = \frac{L}{x} \quad (2)$$

$$\theta = \sin^{-1} \Xi \quad (3)$$

Lightning failure on phase wire

$$D = 8,875 \cdot 10^{-8} \xi I K \Lambda \quad (4)$$

Where the value of D is to obtain lightning density per square meter per year by entering IsoKeraunik Level (IKL)

$$A = (2 \pi + 1) H t^2 + 4 H g (S - H t) \quad (5)$$

Where the value of A is the area of protected area ground wire with meter² unit.

$$L = 100 \cdot \frac{1000}{s} \cdot A \cdot \Delta \quad (6)$$

The L value represents the lightest amount of lightning that may occur in the transmission tower.

$$\text{Log } P\theta = \frac{\theta \sqrt{Ht}}{90} - 4 \quad (7)$$

$P\theta$ represents the probability of failure of ground wire protection.

$$\Sigma \Phi O = P\theta \cdot L \quad (8)$$

The value of SFO is the amount of lightning disturbance on the phase wire per 100 km of introduction per year due to the failure of ground wire protection in each tower construction [3].

2. To get the value of interference on the construction line of Tower of Krian - Gresik, it is necessary picture of transmission tower and its shadow wire [3][6] :

$$\alpha_1 = \sqrt{h_{tp}^2 + \left(\frac{1}{2}c - \frac{1}{2}a_{12}\right)^2} \quad (9)$$

$$\alpha_2 = \sqrt{h_{tp}^2 + \left[a_{12} + \left(\frac{1}{2}c - \frac{1}{2}a_{12}\right)\right]^2} \quad (10)$$

$$\alpha_{1\Box} = \sqrt{(2h_t - h_{tp})^2 + \left(\frac{1}{2}c - \frac{1}{2}a_{12}\right)^2} \quad (11)$$

$$\alpha_2 = \sqrt{(2h_t - h_{tp})^2 + \left[a_{12} \left(\frac{1}{2}c - \frac{1}{2}a_{12}\right)\right]^2} \quad (12)$$

Where the value of

a_1 : the distance between ground wire 1 and phase 1 wire

a_2 : the distance between the ground wire 2 and the phase wire 1

a_1' : the distance between the ground wire 1 and the phase shadow wire 1

a_2' : the distance between the ground wire 2 and the shadow phase wire.

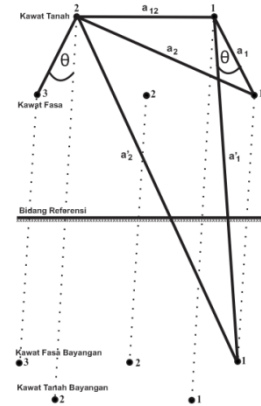


Fig. 1. The transmission structure and the shadow wire

$$K = \frac{\ln \sqrt{\frac{(a_1' \cdot a_2')}{a_1 \cdot a_2}}}{\ln \left(\frac{2hg}{\sqrt{a_{12}r}} \right)} \quad (13)$$

The value of K is the Clutch factor by entering the values obtained in the previous formula

$$Z_g = 60 \ln \left(\frac{2hg}{a_{12}r} \right) \quad (14)$$

The Z_g value is the result of a ground wire impedance

$$\ln R_t = \frac{h_o}{h_t(x_b - x_u)} [x_b(\ln x_b - 0,87) - x_u(\ln x_u - 0,87)] + \frac{h_t - h_o}{h_t} \ln (1,14x_u) \quad (15)$$

The R_t value is the equivalent radius of the Tower by changing the value of the meter unit to the leg unit and the final result is converted back into meters.

$$Z_t = 60 \ln \left(\sqrt{2} \frac{2h_t}{r_t} \right) - 60 \quad (16)$$

The value of Z_t is the impedance value of the Transmission Tower.

$$\alpha = \frac{2 \cdot Z_g}{Z_g + 2 \cdot Z_t} \quad (17)$$

$$\beta = \alpha \square 1 \quad (18)$$

Calculates the transmission coefficient (a) at the top of the tower for the waves coming from the bottom of the tower. Which is used to find the reflection coefficient (b) at the top of the tower for the waves coming from the base of the tower.

$$\varepsilon = \frac{2 \cdot Z_g}{Z_g + Z_t} I \sigma \quad (19)$$

e is the peak voltage of the tower with the peak current value (Is) = 60.

$$\delta = \frac{R_f - R_t}{R_f + R_t} \quad (20)$$

The value of the reflection coefficient (d) at the base of the tower is used to calculate the waves coming from the top of the tower

$$\langle = \frac{2 \cdot Z_g}{Z_g + 2 \cdot Z_t} \quad (21)$$

The value of α is used to find the transmission coefficient at the top of the Tower for the incoming wave.

$$V = K_1 \cdot W^{\frac{K_2 \cdot W}{t^{0.75}}} \quad (22)$$

$$V_{50\%} = \left(1 + e^{\frac{t}{\tau}}\right) + V \quad (23)$$

The value of $V_{50\%}$ is the impulse voltage of the tower voltage (V) with the lightning advance time (t) = 0.5 μ s.

$$\tau_x = \tau + \frac{X_1}{c} \quad (24)$$

Tc is the time when the peak voltage drops suddenly due to the reflection wave (critical time) with the value of the cross-sectional area of the conductor (c) = 300.

$$E_0 = \left(\frac{Z_g \cdot Z_t}{Z_g + 2 \cdot Z_t} I_0\right) / \tau \quad (25)$$

The value of e_0 is the initial stress of the top of the Tower

$$\begin{aligned} Vi = & e_0(1 - k) \cdot \left(t_c - \frac{X_1}{C}\right) + d \cdot e_0 \left(t_c - \frac{2h_t - X_1}{C}\right) \\ & + d \cdot e_0(b - K) \left(t_c - \frac{2h_t - X_1}{C}\right) + d^2 \cdot b \cdot e_0 \\ & \left(t_c - \frac{4h_t - X_1}{C}\right) + d^2 \cdot b \cdot e_0(b - Ka) \\ & \left(t_c - \frac{4h_t - X_1}{C}\right) + d^3 \cdot b^2 \cdot e_0 \left(t_c - \frac{6h_t - X_1}{C}\right) \end{aligned}$$

$$+ d^3 \cdot b^2 \cdot (b - Ka) \left(t_c - \frac{6h_t - X_1}{C}\right) \quad (26)$$

V_i is the isolator voltage by inputting the input value in the previous result.

$$\Pi_0 = E_0 : V_i \quad (27)$$

The value of P_0 is the peak value of a certain lightning current.

$$(Pi\%) = \sum P \times \sum \frac{\text{flicker failure}}{\text{flicker's quantity}} \quad (28)$$

$$(Qi\%) = \sum Qj \times \sum \frac{\text{pounced time}}{\text{amount of time}} \quad (29)$$

The P value is the number of possible flashes. By entering the value of percentage P_i and the percentage of the possibility of a certain lightning current wave advance time (Q_j).

$$0_t = 60\% \times L \times P \quad (30)$$

0_t is the number of lightning disturbances in the transmission tower channel.

III. RESULT AND DISCUSSION

Software testing is divided into two outputs, the first is to analyze the height difference of tower construction on the lightning strike and the second to analyze the tower line Krian – Gresik. Fig. 1 below shows AA Suspension Tower and Fig. 2 describes Tower of Tention CC.

A. Interference at height construction of different tower.

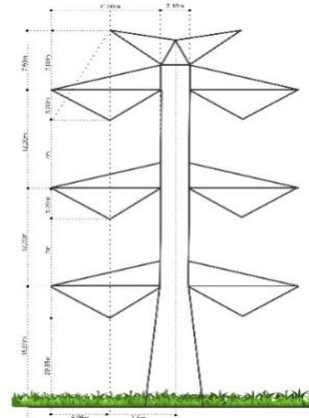


Fig. 2. AA Suspension Tower

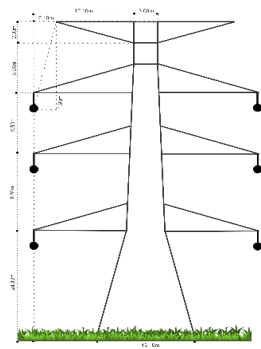


Fig. 3. Tower of Tention CC

TABLE I. THE ANGLE OF SHIELDING BASED ON THE HEIGHT OF THE GROUND WIRE AGAINST THE PHASE WIRE

Pilar	Type	Height Top	L	X	Sin θ	θ
T.15	CC+3	14,4	2,10	15,641	0.1342	7,71°
T.16	AA+3	15.8	5.95	16.883	0.3524	20,63°
T.17	AA+0	12.8	5.95	14.115	0.4215	24,93°
T.18	AA-3	12.8	5.95	14.115	0.4215	24,93°
T.19	AA+0	12.8	5.95	14.115	0.4215	24,93°

In Table 1. Tower Pillar no. 15-19 have different shooting angles due to variations in the high phase wire addition. By obtaining a varying angle it can calculate the flash interruption in each Tower construction [5].



Fig. 4. Results of the program on the AA tower

B. AA Suspension Tower

Fig.4 above shows that a protection angle of 24.93 °. On the angle of shield A suspension tower is considered not good because according to Provoost theory in 1960 it suggested a good shielding state of the transmission tower if it is less than 18° angle [5].

After obtaining the angle of protection it can calculate the value of lightning disturbance in the tower by using formula (8) and obtain the result of 74027 interruption [3].

C. CC Tension Tower

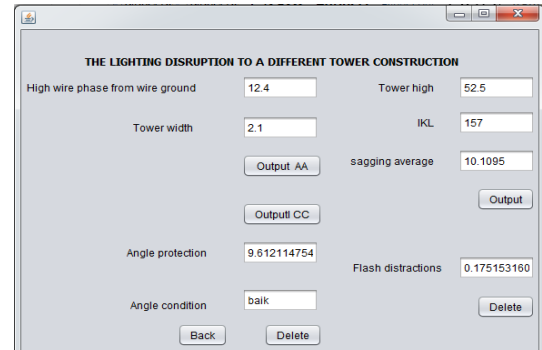


Fig. 5. Program Results on CC Type Tower

Fig. 5 above obtain a protection angle of 9.61°. at the angle of the CC suspension tower shell is considered good because according to the Provoost theory in 1960 it suggests a good shielding state of the transmission tower if it is less than 18° angle. By performing the calculation of the formula (6) then obtaining a lightning distortion value of 0.1751 disorder [3].

D. Disturbance on the line of transmission tower Krian-Gresik.

Average disturbance in the queue - gresik line using the AA tower type suspension. With +0 (AA+0) tower height. In the formula (24) with the critical time (t) 0.5 and the critical current (Io) 60 then obtained:

TABLE II. TIME OF CRITICAL VOLTAGE

Time t (μ second)	Critical voltage (tc) time
0.5	0.5366
1	1.0366
1.5	1.5366
2	2.0366
2.5	2.5366

In table II, inserting different input (t) will produce different critical voltage (tc) time.

TABLE III. TOWER PEAK VOLTAGE

t (μ second)	I ₀ (kA)	E ₀ (kV)
0,5	60	12265.7297
0,5	120	24534.6023
0,5	180	36801.9035
0,5	220	44980.1042
1	60	6133.6505
1	120	12267.3011
1	180	18400.9517
1	220	22490.0521
1,5	60	4089.1003
1,5	120	8178.200
1,5	180	12267.3011
1,5	220	14993.3680
2	60	3066.8252
2	120	6133.6505
2	180	9200.4758
2	220	11245.0260

In Table III. Represents the formula (24) by producing the initial peak voltage value of Tower (E_0).

In Table IV. It is a calculation step to the end. The table above is used to compare all E_0 values with V_i , if the value of $E_0 < V_i$, then *backflashover* or flashover occurs. In $T = 1.5$, when $P_0 = 0,702$ to downwards has *backflashover*.

TABLE IV. VOLTAGE COMPARATOR WHEN HIT BY A STRIKE

T	t_c	I_0	E_0 (kV)	V_i (kV)	$E_0 : V_i$ (P_0)
0,5	0,536	60	12265.729	4552.158	2.695
0,5	0,536	120	24534.602	9101.496	2.695
0,5	0,536	180	36801.903	13652.244	2.695
0,5	0,536	220	44980.104	16686.076	2.695
1	1,036	60	6133.650	5505.214	1.114
1	1,036	120	12267.301	11010.429	1.114
1	1,036	180	18400.951	16515.644	1.114
1	1,036	220	22490.052	20185.787	1.114
1,5	1,536	60	4089.100	5823.370	0.702
1,5	1,536	120	8178.20	11646.740	0.702
1,5	1,536	180	12267.301	17470.110	0.702
1,5	1,536	220	14993.368	21352.357	0.702
2	2,036	60	3066.825	5982.447	0.512
2	2,036	120	6133.650	1196.8954	0.512
2	2,036	180	9200.475	17947.343	0.512
2	2,036	220	11245.026	21935.642	0.512

Fig. 6. Calculation results of channel interference.

Fig. 6 above points out the final result of the disturbance calculation with a disturbance value of 3.9903 flash / 23.7011 km per year.

IV. CONCLUSION AND FURTHER RESEARCH

From the result of this result analysis can be concluded that:

1. On Suspension AA transmission towers get 24.93° angle protection with 74027 flash disturbance and CC

tention tower obtains 9.6121° angle protection with 0,175 lightning disturbance. So, this is more effective using CC tension tower.

2. The calculation of lightning disturbance in the Krian - Gresik line is 3,990 flash / 237011 km, per year is in accordance with existing data from PLN.
3. In lightning disturbance of transmission towers apart from being influenced by different tower constructions are also influenced by the number of days of thunder (IKL)

The results of research on the development of lightning outage application software to detect the Reliability of 500 kV Extra High Voltage Air Channels to lightning strikes can contribute directly to the public because it concerns the continuity of electrical system services in Indonesia. Our further research will be development of lightning outage application software to detect the reliability of 1 MV Extra High Voltage Air Channels.

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Automatic Liquefied Petroleum Gas Leakage Control System Using Proportional Integral Derivative (PID)

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Abstract— Along with the development of technology and information, human needs toward kerosene stove in household sector change over to Liquefied Petroleum Gas (LPG) stove, which is cheaper and more effective. However, the use of LPG stove should consider precised procedures as the gas is easy to explode. One of some causes of gas explosion and burn is when people forget to turn off the stove while cooking and an existing gas leak. To address such human errors, a microcontroller-based tool needs to be developed to ably detect a gas leak and control the gas stove automatically. Equipped with a stepper motor, the tool can regulate the gas flow and the stove temperature. The tool also has a buzzer as a gas leak indicator and an LCD used to display the detection results from the MQ6 sensor. The MQ6 sensor is used as a gas detection and thermocouple sensor to identify the stove temperature that will be displayed in the seven segments. The gas stove's automatic control uses Proportional Integral Derivative (PID) method that can make precised valve opening angel of the stepper motor. The result of this research is expected to troubleshoot gas explosion and burn problems caused by the LPG stove.

Keywords— *Microcontroller; MQ6; Motor Stepper; PID*

I. INTRODUCTION

Gas sensor technology has been used in several studies. Detection of gas NH₃ and H₂S through sensor MQ-137 and MQ-136 overcome the harmful excess gas on the farm specially hazard for cow health [1]. Measuring the shale gas content helps to improve the accuracy of shale gas resource assessment, and obtain an unattended shale gas metering system [2]. The infrared leak detection technology can detect and locate the gas leakage using of SF₆ equipment [3]. Embended system using MQ-9 chemical sensor investigated, the aim of this system in order to detect dangerous gas specially hydrocarbon [4].

Since the removal of subsidies on kerosene by Indonesian government, many people began to use Liquefied Petroleum Gas (LPG) cylinders for daily use. However, there are still numbers of people especially in rural areas who use kerosene for certain rationales. For instance, they are reluctant to use LPG because they might not be able to afford it as it is slightly more expensive compared to that of kerosene. They are also afraid because LPG has a big possibility to explode in sudden

times. As a technical matter, they lack of knowledge in operating the procedures such as installing and removing the regulator hoses, checking the hoses condition, and indicating the existing gas leak.

In addition, the unavailability of the prevention procedures given by Indonesian government regarding the case addressing a gas leak makes people more frightened to use LPG. Actually, an early prevention of gas explosion can be indicated through the presence of gas leak. However, not so many people understand the indicators of existing gas leak. Along with the development of technology, a security system is developed by creating automatic control and protection system toward a gas leak phenomenon in LPG cylinders case. By the presence of this tool, people can know easily some indicators of a gas leak.

Liquefied Petroleum Gas Leakage Control System has been investigated several researchers. Gas leakage is detected the sensor then detect the leakage, an alert message will be sent to the certain person related to the gas leakage [5]. Improvement on gas leakage detection and location system based on wireless sensor network for various gas has been investigated [6]. Liquefied Petroleum Gas detection and control integrated with communication between the microcontroller and the GSM proven has been solving the LPG leakage [7]. However [5,6] still not specific discuss about LPG but various gas, while [7] not yet researching about how controlling the leakage using control system.

The purpose of this research is to solve this problem by design and implement automatic liquefied petroleum gas leakage control system using PID. Generally, the development of the aforementioned system is to help people early prevent a gas leak problem. Further, they can live safer because they know early the cause of gas explosion and burn.

II. THEORY

A. Microcontroller

Microcontroller is a complete computer in a form of a small chip containing ROM (Read-Only Memory), RAM (Read-Write Memory), DAC (Digital to Analog Converter) and communication serial. Among other types, AVR

microcontroller has been widely used today. There are many types of it such as ATmega16, ATmega8, and ATmega32. To be able to program the ATmega16 microcontroller, one might use Code Vision software in which the programming language uses language C that lays between a high level programming language and the Assembly. ATmega16 basically has four different Ports namely Port A, B, C, and D. There are 8 pins in each port that can be operated when programming an electronic tool (see Figure 1)[5].

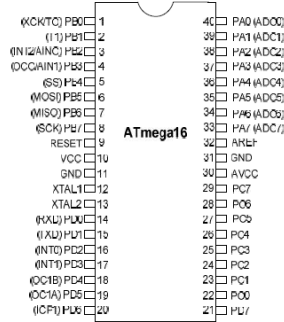


Fig. 1. . Datasheet of Atmega16

MQ6 is a type of gas sensors functioning as a detector for LPG, of which containing of propane and butane compounds. The difference between MQ6 and other sensors is at the sensitivity capability. The more expensive the sensor, the better its sensitivity. Among other gas sensors such as MQ2, MQ5, TGS2610, and AF30, MQ6 sensor can detect a gas presence from 200 to 10.000 ppm. This typical sensor has a high sensitivity level and a fast detecting process. This sensor only needs 5 Volt to run. Figure 2 shows how MQ6 sensor looks.



Fig. 2. The shape of MQ6 gas sensor

B. Thermocouple Sensor

Thermocouple sensor acts as a temperature detector that consists of two different conductors named thermo-elements. Each conductor is isolated but not at the junction point. There are several types of thermocouple that can be drawn as follows:

1. Type B can measure temperature ranging from 100°C to 1800°C.
2. Type E can measure temperature ranging from -270°C to +790°C.

3. Type J can measure temperature ranging from -40°C to 750°C.
4. Type K can measure temperature ranging from from -200°C to +1200°C
5. Type N can detect temperature ranging from -260°C to 1300°C.
6. Type R is less sensitive to the inputs, but can measure temperature up to 1600°C.
7. Type S can detect temperature ranging from -50°C to 1760°C. This type of thermocouple sensor is more expensive compared to other types.
8. Type T can detect temperature ranging from 0°C to 300°C.[8]



Fig. 3. Thermocouple sensor Type K

C. Proportional-Integral-Derivative Controller

Proportional-Integral-Derivative (PID) controller is a combination between three types of controller namely proportional, integral-proportional and derivative-proportional controllers. If the three controllers work separately, they might work not good because each controller has its own advantages and disadvantages.

Proportional controller is a linear reinforcement whose gain can be adjusted. The relationship between output $m(t)$ and error signal $e(t)$ can be formulated as follows:

$$m(t) = K_p e(t) \quad (1)$$

K_p : Gain proportional

$m(t)$: Controller output

$e(t)$: Error signal

Integral-proportional controller is a transformation from the integral control output $m(t)$, changing with the same time function along the error signal. The relationship between the controller output $m(t)$ and the error signal $e(t)$ can be equated as follows:

$$m(t) = K_p \cdot e(t) + \left(\int_0^t e(t) dt \right) \quad (2)$$

K_p : Gain proportional

T_i : Time derivative provisions

Derivative controller can also be called as a rate controller because the controller output is the same as the change in error signal. When the lapse time T_d is the time interval of the progressive proportional controller's responses affected by the

action rate, the constant time T_i adjusts the action of the integral control while K_p strengthens the proportional or integral part of the action control.

$$m(t) = K_p \cdot e(t) + K_p \cdot T_d \frac{\partial e(t)}{\partial t} \quad (3)$$

K_p : Gain proportional

T_d : Time derivative provisions

The combination between proportional, integral, and derivative controllers are known as the PID method. This PID method has the advantage in correcting signal errors compared to each of the three controllers. The PID control equation can be given as follows:[7]

$$m(t) = K_p \cdot e(t) + \frac{K_p}{T_i} \int_0^t e(t) dt + K_p \cdot T_d \frac{\partial e(t)}{\partial t} \quad (4)$$

D. Liquid Cristal Display (LCD)

Liquid Cristal Display (LCD) is one of the electronic components that serves to display data either characters, letters or graphics. It consists of 16 pins, one of which functions as a display contrast controller. The LCD display (Figure 4) is available in a module form that consists of the LCD display itself and its supporting circuit including ROM.



Fig. 4. The shape of LCD

III. METHODS

The system designed in this research was an automatic stove and leaking gas detection using the electronic components namely MQ6 gas sensor to detect a gas leak and a thermocouple sensor to detect a cooking temperature. This system, moreover, was divided into two processes namely the leaking gas detection process and the cooking temperature detection process in which all results will be displayed on LCD and the seven segments. This study used the following methods:

1. Quantitative
Revealing supporting theories or previous studies aimed to make a research on an automatic stove and gas detector function as well as possible.
2. Observation
Registering the used tools and systems aimed to get the analysis results and conclusions regarding the tools and systems.
3. PID Method
PID method functioned as a controller of a gas flow on a gas valve to the stove.
4. Designing Method of the Hardware
The method to design the hardware was a stage to assemble parts into a hardware device, such as wiring

and soldering the seven segment which required additional resistor components.

5. Designing Method of the Software

Software design consisted of several programs or different software uses. The program to be made consisted both food temperature detection program and leaking gas detection program. The software used to program was Code Visio AVR. To enter the program into the microcontroller, an eXtreme Burner AVR software was employed.

According to Figure 5, the design of an automatic control and LPG leakage protection systems in the present research included a gas sensor named MQ6 which functions to detect LPG gas leaks. This system also covered a thermocouple sensor as a temperature sensor used in a gas stove to determine the stove temperature. The undertaken process in the microcontroller program can be explained as follows:

The first process was defining 500 ADC in Code Vision AVR program. If the MQ6 sensor conveyed more than 500 ADC, the LCD would display a sign "Dangerous" and the buzzer would sound indicating an existing gas leak. Otherwise if the ADC value showed less than 500, the LCD would display a sign "Safe" and the buzzer was in the off mode indicating no gas leak. When there was no gas leak, the next step was determining the temperature set displayed on the seven segments. Then, the thermocouple sensor detected the temperature of the flame on the gas stove. If the thermocouple sensor detected a temperature overreaching the early set point, the stepper motor would rotate to reduce or to increase a gas flow so that the temperature could be stable according to the set point for a minute. After a minute, the stepper motor moved to close the gas valve, in which the method used here was PID method.

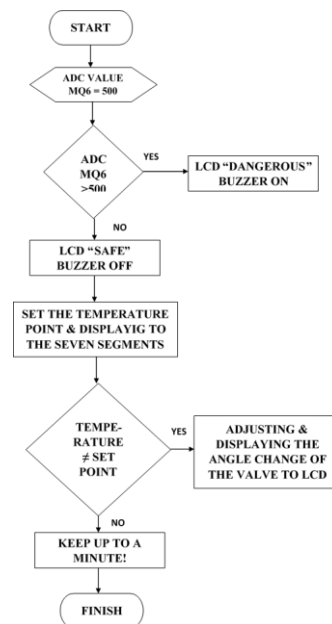


Fig. 5. Whole system algorithm

IV. RESULTS AND DISCUSSION

A. MQ6 Sensor Test

MQ6 sensor test was to reveal how MQ6 sensor was well-functioned. Besides, the test was addressed to know the part per million (ppm) value of the gas when leaking.

TABLE I. RESULTS OF MQ6 SENSOR TEST

No.	PPM	ADC	X	Total Bit	Status
1.	3052	319	9.5703125	1024	Safe
2.	5600	585	9.5703125	1024	Dangerous
3.	5128	536	9.5703125	1024	Dangerous
4.	4788	501	9.5703125	1024	Dangerous
5.	5688	594	9.5703125	1024	Dangerous
6.	5400	564	9.5703125	1024	Dangerous
7.	4860	508	9.5703125	1024	Dangerous
8.	5468	571	9.5703125	1024	Dangerous
9.	5380	562	9.5703125	1024	Dangerous
10.	5616	587	9.5703125	1024	Dangerous

Table I. concluded that the MQ6 sensor was in a good condition and could be used. The status was influenced by the program that had been determined. For instance, if the ADC value was more than 500, the gas sensor would show a dangerous sign and the buzzer sounded. Meanwhile, if the value was less than 500, the sensor would indicate a safe sign (see Figure 6 and 7).



Fig. 6. Dangerous condition



Fig. 7. Safe condition

The way to determine the ppm value could referred to the ADC conversion equation as drawn below:

$$\text{ADC conversion} = \frac{V_{in}}{V_{ref}} \times 1024 \quad (5)$$

V_{in} : Input voltage

V_{ref} : Reference voltage

$$X = \frac{\text{Range}}{\text{Total Bit}} \quad (6)$$

For the Analog to Digital Converter (ADC) 10 bits on ATmega16 microcontroller, the resulting output was 2 powers of 10 equal 1024. MQ6 has a detecting range from 200 to

10000 ppm. Based on the seventh equation, so that X value can be obtained as follows:

$$\text{Total Bit} = 1024 \quad (7)$$

$$X = \frac{\text{Range}}{\text{Total Bit}} \quad (8)$$

X value (9.5703125) was then inputted in the third equation. The ppm measurement in accordance with the MQ6 sensor datasheet started from 200 to 10000 ppm. The reference voltage used was 4V, which was equivalent to 10000 ppm. So that, based on equation 2, the increase in X / ppm per 1 bit was equal to 9.5703125. For example, with the voltage $V_{in} = 2V$, $X = 9.5703125$ was inserted to equation 3 to convert to ppm. [9]

$$\text{ppm} = X \times \text{ADC conversion} \quad (9)$$

B. Thermocouple Sensor Test

Thermocouple sensor test was done to reveal thermocouple Type-K and know whether the developed program worked well. The thermocouple Type K worked relevantly to the food thermometer sensor examined as a calibration (see Figure 9). After the test conducted, the thermocouple sensor Type K as well as the program worked greatly. Table 2 shows the results of the test.



Fig. 8. Calibration of the sensors

TABLE II. RESULTS OF THERMOCOUPLE SENSOR TEST

No.	Ingredients	Temperature		Thermometer Temperature	Vout
		R	M		
1.	Water 1L	28°C	105°C	106°C	15μV
2.	Water 2L	28°C	135°C	135°C	21μV
3.	Water 3L	28°C	145°C	146°C	23μV
4.	Egg	28°C	138°C	138°C	22μV
5.	Noodle	28°C	135°C	135°C	19μV
6.	Sweet potato	28°C	140°C	141°C	22μV
7.	Cassava	29°C	160°C	162°C	26μV
8.	Bean sprouts	28°C	120°C	120°C	18μV
9.	Potato	28°C	136°C	137°C	22μV
10.	Vegetable	28°C	130°C	130°C	20μV

Note:

Temperature R: Room temperature

Temperature M: Cooking temperature

Vout: Thermocouple output voltage level

According to above experiment, the eggs were 0.5 kg with 1.5 liter water, while for the noodle was 2 packs with 1.5 liters

of water. The sweet potato was 1 kg with 2 liters of water, while the cassava was about 1 kg with 1.5 liters of water. The bean sprouts were 0.5 kg with 2 liters of water. The potatoes were 0.5 kg with 2 liters of water, while the vegetables were 0.4 grams with 2 liters of water.

C. PID Method Test

Table III shows the results of PID method test.

TABLE III. PID METHOD TEST

No.	Ingredients	Reference Temperature	PID Temperature	Error (%)
1.	Water 1 liter	105 °C	113 °C	7.6
2.	Water 2 liters	135 °C	140 °C	3.7
3.	Water 3 liters	145 °C	150 °C	3.4
4.	Noodle 2 packs	135 °C	142 °C	5.1
5.	Sweet potato	140 °C	148 °C	5.7
6.	Cassava	160 °C	164 °C	2.5
7.	Egg	138 °C	142 °C	2.8
8.	Bean sprouts	120 °C	125 °C	4.1
9.	Potato	136 °C	138 °C	1.4
10.	Vegetables	130 °C	133 °C	2.3
Average				3.86

Of the 10 trials using the PID method, all resulted that the temperature values could be analyzed because the entire experiment was successful. However, the thermocouple sensor value's decrease temperature worked too long. Such phenomenon made the thermocouple temperature value greater than the value of the determined set point or the reference temperature. Besides, the wind factor greatly influenced the detected thermocouple sensor temperature value. Table 3 shows that the average temperature error using the PID method was 3.86% with the lowest error value of 1.4% and the highest error value of 7.6%. The error occurred because the temperature of the thermocouple sensor decreased very long and was affected by the surrounding wind. Therefore, there was a difference between the set point value and the temperature value using PID method.

V. CONCLUSION

A. Conclusion

In accordance to the above findings, this research concludes that MQ6 sensor can detect gas leak when the ACD value is more than 500. In this case, the buzzer will sound and the LCD will display "Dangerous" sign. The used PID method

on automatic stove system can function well although the thermocouple works very slowly. Thermocouple sensor functions greatly because the calibration value is similar to the food thermometer.

B. Suggestion

This research suggests that a highly sensitive sensor needs to be used to better detect gas in LPG cylinder such as TGS2610. Another recommendation is that the use of thermocouple sensor is less accurate when there is wind surrounding the tool because it will affect the temperature results.

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Automatic Application Of Graphic Design To Banner Model

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Abstract— Banners are one of the promotional tools. Banners have been printed with digital printing. Banners are usually used as media announcements or conveying aspirations about an activity. Banner is a simplification of billboards. Banners are usually designed in portrait or vertical form. Until now, banner creation always uses design applications like Photoshop or CorelDraw. However, this application still requires accuracy in its use. In addition, the application to design still requires other applications that support it to be a beautiful banner. In addition the user must first know the function of the tool from the application before starting to design. Therefore, this research makes an automatic application for designing banner models. In this application to design the background choices needed first, then each background has a layout for the banner design until the process is complete. Some solutions for automatic applications in designing a banner starting from the background design that is influenced by the position of the image that matches the size of the banner has not been done. Hopefully this research will contribute by automatically giving banner promotion media in designing it to produce attractive appearance as desired and having high persuasive value compared to other design applications separately so that users can minimize design time because there is no need to design the background. Various tests are carried out by calculating the comparison of the time duration of the banner design with the automatic application and using the Photoshop application. Therefore, the application in this research has proven the effectiveness of visual and wide space in conveying messages digitally printing and supported by the placement of appropriate images. Automatic application testing for banner models has reached a faster time than using a Photoshop application which is a 60 minute time difference and the testing process uses design data in educational activities. In addition to testing based on the duration of time, this application has also produced a banner model with a background image size of around 1,024 Kb has reached a damaged image only an average of 13% smaller.

Keywords— *Application; Automatic; Design Graphic; Banner Model*

I. INTRODUCTION

Technological developments have now brought significant changes, especially in the world for design. Design is one of the attractions of a person to an item so that the design is needed by a company to promote its goods. Promotion is any form of communication used to inform, persuade, or remind people of products produced by organizations, individuals, or households [1]. Submission of information or promotion can be

done in many ways, either through online media or print media. Online media is very much in demand. However, with online media can add to the habit of someone getting to know the virtual world so that a sense of lack of environmental care because there are no more people buying newspapers to read the news or see advertisements, all have focused on the gadget [2]. Some studies have shown that not everyone in Indonesia can access the internet. Therefore print media is also very necessary for promotion to add business value and support the success of the program. Media promotion is divided into two parts, such as: media above the line, such as: television, radio, cinema and newspapers and media under the line, such as posters, banners, brochures and multimedia presentations [3]. Each type of media has different characteristics, with almost the same ratio. Currently there are many social media that can help share information using the internet. However, information through print media is still an effective way.

One of the printing tools is a banner. Banners are one of the information media used to inform an activity or this is only to convey aspirations. Banners have varying shapes and sizes [4]. The design of the banner is adjusted to the theme that has been made. While the influencing elements of graphic design, such as: typography, layout, and color. Typography is a graphic design that is used to explain, representing a form of verbal communication that is expressed visually [5]. The layout is the management of forms, fields and other design elements into the field so that they become artistic [6]. The layout also has the main purpose of displaying text and image elements so that they are communicative and make it easy to receive the information conveyed. While colors can be grouped into four categories, namely: primary, secondary, tertiary and neutral. Color is used to communicate feelings, attract attention, identify products, or organize information. Color is very influential in decision making when buying products [7].

Some solutions for product design in the form of banners have been made. However, the solution is not to provide an automatic application in one process can produce a beautiful banner design. Applications commonly used for banner designs such as Photoshop or CorelDraw. However, this application still requires accuracy in its use. Photoshop is an application used to modify images or photos by digital photographers and advertising companies. While Coreldraw is a vector graphics editor based on mathematical equations [8]. Photoshop or Coreldraw has the ability to read and write raster and vector format images such as .png, .gif, .jpeg, and others. But to be able to use this application, the user needs time to learn the

tools that are in Photoshop or Coreldraw. So it takes a long time. Therefore, this research makes an automatic application for designing banner models. The purpose of this research is to be able to automatically provide banner promotion media to design it so as to produce an attractive appearance as desired and have high persuasive value compared to other design applications separately and can minimize design time because there is no need to design the background first.

II. RESEARCH METHODS

Banners are banners derived from the Latin "banderia" or "bandum". The banner itself according to Wikipedia is a flag or piece of cloth containing symbols, logos, slogans or other messages[9]. The development of banners is used as a medium for good promotion by large companies to the street vendors. Banners are installed in high-rise buildings, strategic locations reach villages. As a promotional media, banners are categorized as below the line media. Below the line media is an advertising activity that does not involve advertising in the mass media. Therefore, the banner is a medium whose nature makes it easy for the public to see one message or one product. Promotional media banners have several characteristics such as: large enough reach and cheap production costs (as strength). While the weaknesses, the information displayed is limited, the capacity is low, tax costs and licensing are high, security is not guaranteed, if the position is not strategic and the right segmentation that is not targeted is not achieved. But the discourse structures that will be studied about are Theme (Thematic), Source, Audience, Location where the banner is installed, the time it is installed and the Rhetoric. This is the most important piece of information from the text that has been conveyed to everyone. Image size in the background greatly affects the quality of the printed banners in a promotional media. A good picture is usually a large file size. Images are affected by image dimensions (length and width) and image depth (bits per pixel). The dimensions of the image are quite clear, what is the length and width of an image in pixel units. For example: 640×480 , 800×600 , 1024×768 , etc. While the depth of the image is the space provided to hold color information in one pixel (Pixels are the smallest units of the image dimension). For example we have an image file with a size of 100×100 pixels, a depth of 24 bits. Then the original file size is: $100 \times 100 \times 24 = 240000$ bit = $240000/8$ Byte = 30000 Byte = 29.30 KB.

The input data in this study is the data background for 5 activities, such as: entertainment, sports, education, Islamic activities, etc. Furthermore, data analysis has been collected to gradually create applications, including: system design using UML, designing interfaces, coding using the Visual C # 2010 programming language, and implementing applications using Microsoft Windows 8.1 Pro 64 bit operating systems. In the design phase UML will be explained about the design of the application system model. The design of this application system model is used to define in detail the devices, processes or systems so that they can be realized in physical form [10]. The model produced during the design describes "how" the problem is solved in the form of software specifications that are ready to be implemented [11]. Interface design designs the interface for this application. While the coding stage, the

program code is created and explained. The last stage is the stage of applying automatic graphic design applications for banner models.

The usecase diagram is an illustration of the interaction between the components of a system to be built [12]. Users can access the main menu which consists of 3 menu options, the menu selects the background, the image input menu and the text input menu for the banner title, can be seen on Fig 1. While the interface is needed an application that helps users to see the desired appearance, and provide comfort in seeing it. In this interface design must be considered the things needed by the user [13]. In this study the interface design can be seen in Fig 2 and an explanation of Fig 2 can be seen in Table 1. Flowchart is a series of charts that illustrate the flow of the program, can be seen in Fig 3.

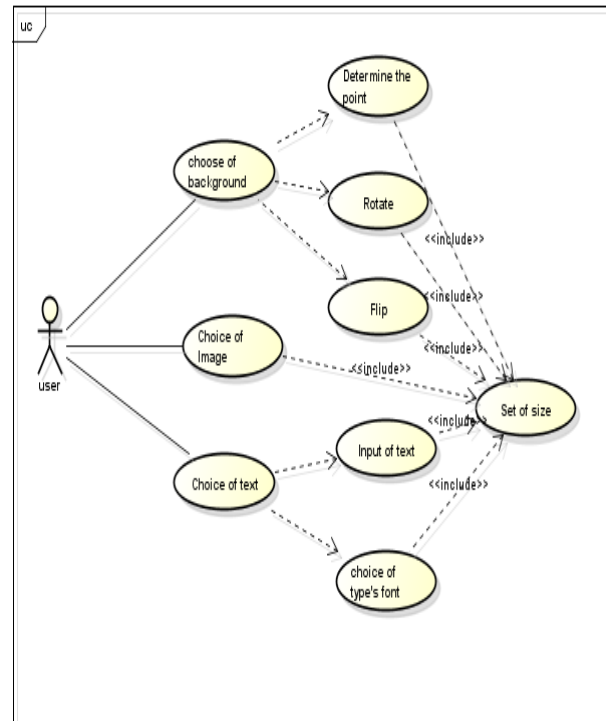


Fig. 1. Usecase Diagram of Automatic Automatic Application of Graphic Design to Banner Model

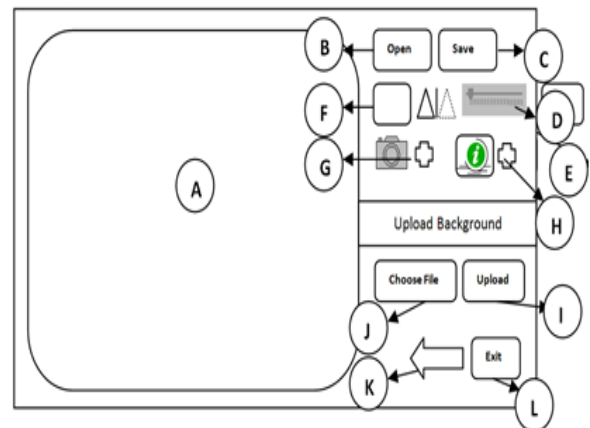


Fig. 2. Interface Design

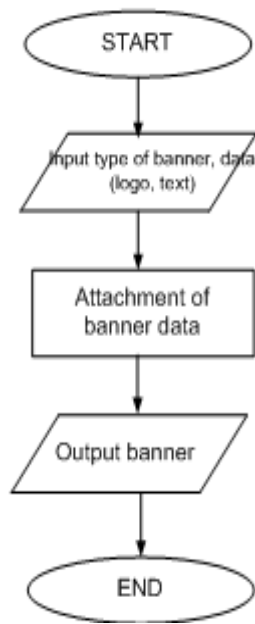


Fig. 3. Description of The Interface Design

TABLE I. DESCRIPTION OF THE INTERFACE DESIGN

Name	Function
A	Picturebox is a background place and enter the picture
B	The open button is the button used to open the background file directory
C	To save the results of the banner that has been created
D	Change the background size that has been input
E	The flip serves to mirror images
F	To rotate the image 90 degrees
G	To add images to the background
H	To add text to the background
I	To move background / upload background files
J	To open the background file directory that will be uploaded
K	To return to home
L	To exit the application

III. RESULTS AND DISCUSSION

The results of the research are done by displaying a menu that can be accessed by the user, with several menu options. In this initial view only consists of background and buttons, there are two buttons, namely Start Design, and About. For Start Design itself is a button that points to the main menu of the program. When the button is clicked, the user will immediately see the core display or the main menu of the program. Display to add an image, can be seen in Fig 4. While the display for entering text can be seen in Fig 5.



Fig. 4. Menu of Add The Picture

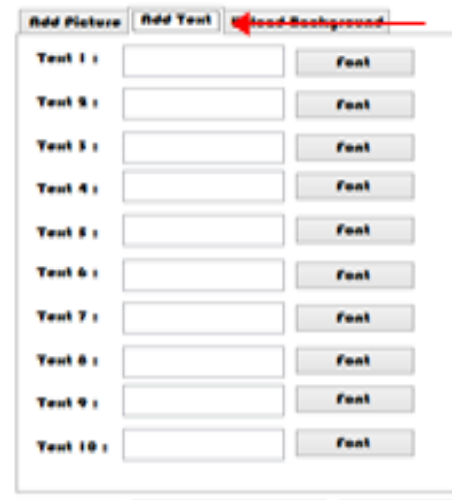


Fig. 5. Menu of add The Text

Several trials have been conducted in this study by calculating the comparison of the length of time to design banners with automated applications and banner designs using Photoshop applications, can be seen in Table 2. Trials through automated applications for banana design have reached a faster time than using design applications using photoshop. In

addition the trial was carried out based on the size of the image in an activity. Activity categories in banners will certainly affect the effectiveness of delivering a message. For this reason in conveying messages in the form of images on education and entertainment activities has reached a size of 1024 Kb, for more details can be seen in Fig 6.

TABLE II. RESULT OF TIME CALCULATION

PROCESS	Duration Time (minutes)	
	Photoshop	This Software
DETERMINE SIZE	10	10
ENTER TEXT	15	15
MODIFY TEXT	45	15
MODIFY BACKGROUND	45	15

the process is complete. Some solutions for automatic applications in designing banners starting from the background design that is influenced by the position of the image in accordance with the size of the banner has not been done. Based on the results of research that has been done on visual graphic design applications for banner models by providing background choices and there are children who currently with banner designs reach a faster completion using Photoshop or Corel Draw applications, which have reached 60 times a minute, free on table 3. although there are some things that are faster than design applications using photoshop. In addition to conveying the message in the form of an image on the activity will affect the image in the delivery of the message, shown in Figure 6, where the image size as a background with a size of 1024 Kb has reached the damaged image only an average of 13% smaller. Therefore this application is very helpful for users to make banners with simple tools. and easily understood by users who have never used well-known editing applications such as Adobe Photoshop and Corel Draw, and can allow design time. Therefore, the application in this research has proven the effectiveness of visual and wide space in conveying messages digitally printing and supported by the placement of appropriate images.

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RESULT OF SIZE BROKEN IMAGE TO SEVERAL ACTIVITY

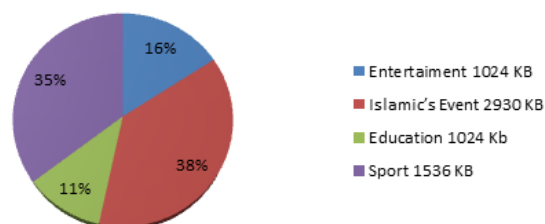


Fig. 6. Result of Size Broken Image Background of Banner

IV. CONCLUSIONS AND FUTHER RESEARCH

Banners are one of the promotional media as media announcements or convey aspirations about an activity. Banner is a simplification of billboards. Until now, banner creation always uses design applications like Photoshop or CorelDraw. However, applications in Photoshop or CorelDraw still require precision in their use. In addition, Photoshop or CorelDraw for design still requires other applications that support it to be a beautiful banner. users in the Photoshop or CorelDraw application must first know the function of the tool from the application before starting to design. Therefore, this research makes an automatic application for designing banner models. In this application to design the necessary background choices first, then each background has a layout for banner design until

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