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SWISS GERMAN UNIVERSITY

MASTER OF INFORMATION TECHNOLOGY

THE ANNUAL MIT CONFERENCE

Applied Research Collaboration in Smart Cities for Facing MDG* Challenges toward Indonesia Initiative Maritime Axis and ASEAN Economic Community 2015

June 13, 2015

Volume 2

Preface

Serpong, Swiss German University, 13th of June 2015

In the name of God The Most Supreme and Most Merciful,

It is great honor and very pleased Annual Conference on Management and Information Technology is conducted to reach the highest academic achievement and research contribution. Despite all tribulations facing across we succeed over them and now we all can celebrate it in ACMIT 2015. Thank God…

In this moment I am standing here on behalf of esteemed ACMIT Committee would like to greet honorably our guests, lecturers, students and friends, hence, we will enjoy together our achievement and long standing learning journey. Congratulations to you all and thank you for such valuable opportunities, efforts and supports given.

The theme of research, i.e. "Applied Research Collaboration in Smart Cities Facing Indonesia Maritime Nationwide Initiatives and Millennium Development Goal Challenges toward ASEAN Economic Community 2015" is carefully picked; therefore, we would then dream, set ourselves higher objectives and standards to achieve it together while benefitting society, international community, particularly and absolutely Indonesia our beloved Country.

We have admitted this year Annual Conference MIT out of 21 papers being submitted only 10 papers deemed to be presented and considerably minimum numbers; however, we should never stop: our dreams, our struggles and our fulfillment to exceed beyond our own credo academic excellent. Please allow me to quote, one of favorite Disney's Movie is: "Keep Moving Forward". That's all we can do our honorable guest, colleagues, students and friends.

Finally have fun and see you next year in 3rd Annual Conference MIT, 2016. May Gob bless us all. Thank you.

Chairman of Annual Conference on Management and Information Technology,

(signed)

Dr. Mohammad. A. Amin Soetomo

Rundown

Time	ACMIT Conference June 13, 2015, Swiss German University Campus, Tangerang, Indonesia
08:00 –08:30 08:30 –09:15	Greeting and Registration Prayers & National Anthem of The Republic of Indonesia ACMIT 2015 Conference Report by Chairman (Dr. Ir. Moh. A. Amin Soetomo, M.Sc.) Welcoming Speech by Dean FEIT SGU (Dr. Ir. Gembong Baskoro, M.Sc.)
09:15 –10:15 10:15 – 11:15 11:15 – 11:20 11:20 – 13:00 13:00 – 16:00 16:00 – 16:30	Presentation by Keynote Speaker (Prof. Ir. Houtman P. Siregar, M.Si, Ph.D, Dr. Ir. Gembong Baskoro, M.Sc, & Dr. Ir. Hanny Y. J. Berchmans) Presentation by Director PJK BKPM RI (Drs. Siswantoro M.Si) Photo Session (VIP Guest may be excused from event) Lunch/ISOMA Parallel Research Presentation Plenary Session Reception & Closing

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Automation of Process Control in Chemical Plant

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Abstract

Automation of process control in chemical plant is an inspiring application field of mechatronic engineering. In order to understand the complexity of the automation and its application require knowledges of chemical engineering, mechatronic and other numerous interconnected studies.

The background of this paper is an inherent problem of overheating due to lack of level control system. The objective of this research is to control the dynamic process of desired level more tightly which is able to stabilize raw material supply into the chemical plant system.

The chemical plant is operated within a wide range of feed compositions and flow rates which make the process control become difficult. This research uses modelling for efficiency reason and analyzes the model by PID control algorithm along with its simulations by using Matlab.

Keywords: Automation; PID; Process Control

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1. Introduction

Automation of process control in chemical plant face many challenges on how to ensure the rapid real time sampling and how to ensure that the correct data transmisions so the system could be controlled accurately. It is difficult due to their non linear, time varying behaviour and poor quality of available measurement [1].

It is also essential to know and include the desired output to realize the superiority of control performance in term of higher accuracy and provide a robust control perfromance. The controller that is being introduced focus on PID algorithm with variable gains. By manipulating some variables, the controller would be able to take control of the dynamic behaviour of process control in the chemical plant.

The proportional integral and derivative (PID) controller has only 3 parameters but without a systematic procedure, it is not easy to find good values for them [2].

2. Literature Review

In chemical plant, liquid such as acid is used in various process. The amount of such liquid stored can be found by measuring the level in the storage tank. The controller should be able to handle a bulk of quantity of material therefore it should be studied and verified well before its implementation.

2.1. Sensor and Actuator

Acid chemical is a corrosive material therefore the selection of sensor is crucial to the overall control system. The indirect method of capacitance sensor is recommended. An insulated electrode act as one plate of capacitor and the tank wall acts as the other plate. The measurement work is based on change of capacitance made by applying RF signal between conductive probe and the vessel wall. And converted into signals by transducer. The potential difference across sensor at constant current is the measure of level. The potential difference then amplified by an operational amplifier to give a voltage which can directly drive a display [3].

Beside the sensor, the selection of an appropriate actuator is also crucial to the overall control system. A motorized valve that is coated by teflon with butterfly design is recommended since tight sealing is one of the main concern in the operation of the plant. Its design with several levels of shaft safety sealing could prevent leakage problems.

2.2. Controller

In order to get an accurate control, a simple turn   On/Off will not work well especially when controlling large volumes of liquid chemical as they tend to introduce an oscillation of level around the set-point in a sinusoidal pattern.

Automatic control have variety of forms like an open loop, a single close loop and a cascade control. Beside that, there are many control methods such as Sequential Control, Relay Logic Control, PID, Fuzzy Control and Model Predictive Control. So far in industrial application, the PID control of single close loop is applied as the most applicable control.

As for PID controller, there are digital PID and analog PID. The digital PID is more convenient to use because it gives more accurate control than analog PID controller [4]. PID controllers optimize close loop performance and improve robustness in the varying time delay system by comparing the measured actual value with respect to its set point, and manipulating of the process in a way that will hold the variable at its set point when a disturbance changes the process.

The variable being adjusted is called the manipulated variable which is equal to the output. The output will be changed in response to change in measurement or set-point.
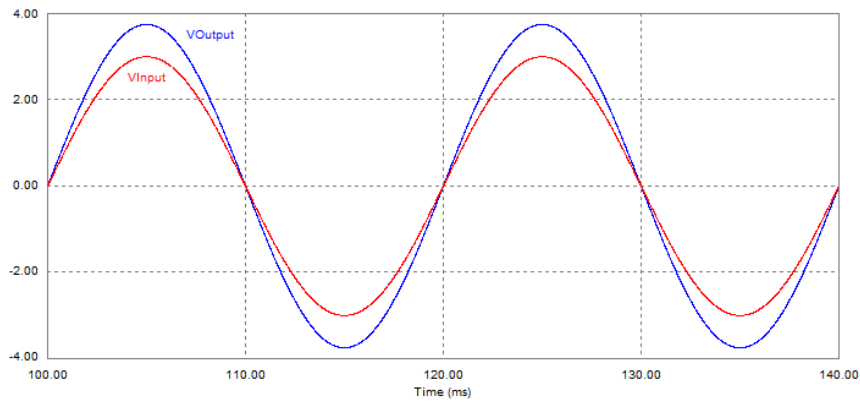

Fig 1. PID Response Signal
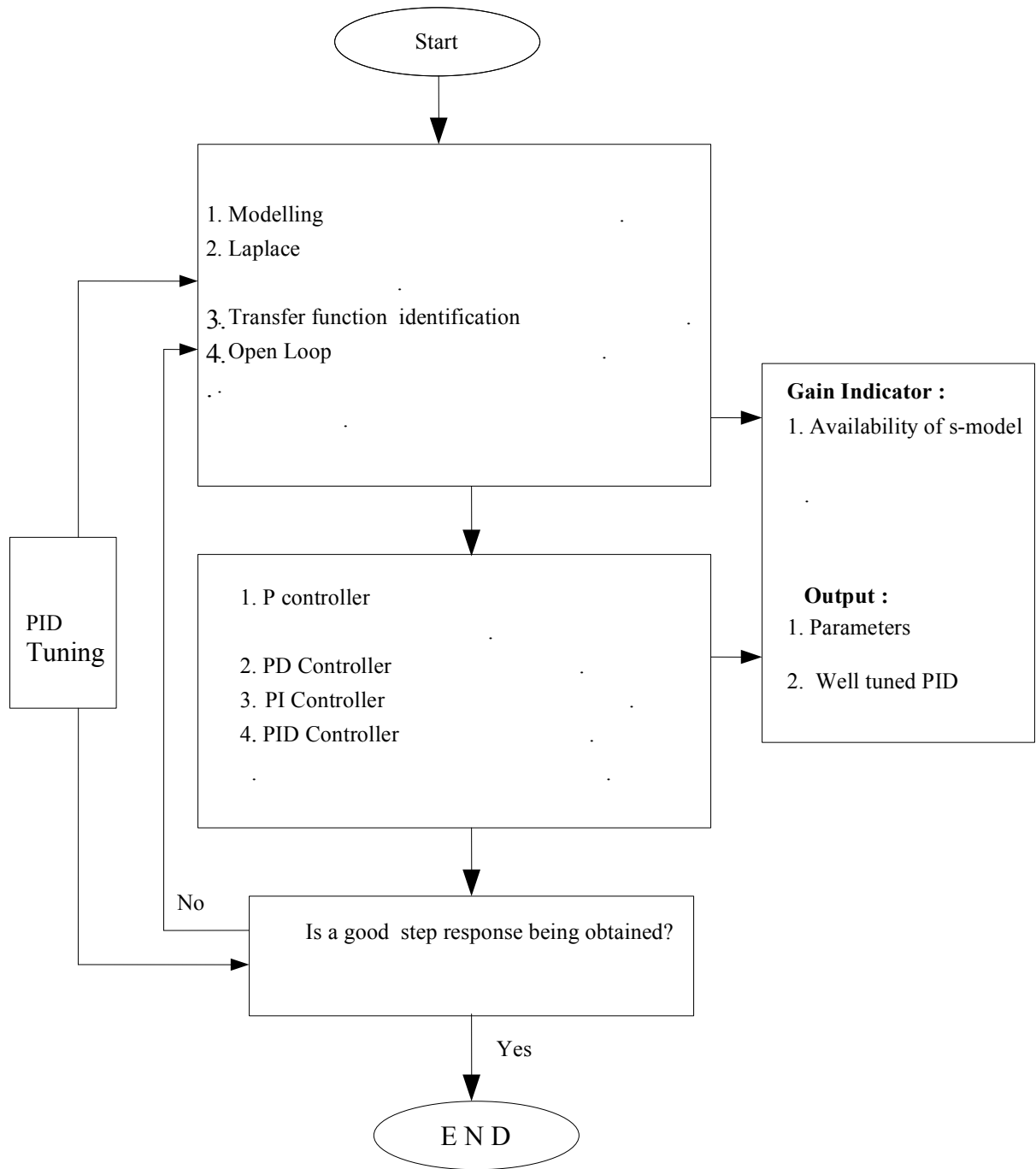
3. Research Flowchart

Fig 2. Research Flowchart

Step 1. The research started from modelling of the level system. By knowing the mathematical model and do the laplace transform, it would be able to find the transfer function of the system in first or second order. In this step, the research started to find out step response of an open loop. The gain of this step is to have mathematical model in s-domain.

Step 2. The research then continued by checking the response of the control system using P controller and then using the combination of PD, PI and PID in order to find the best step response. The expected output from this second step were optimum controller parameters and well tuned PID controller or else the PID tuning should be repeated again.

4. Result and Discussion
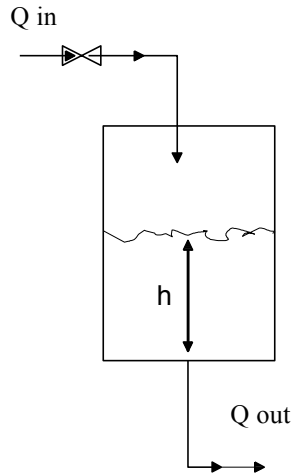
4.1. Modelling

Q in

Fig 3. Level Model in Storage Tank

The model of behaviour of the tank is necessary so the changes in level due to changes in flow conditions can be predicted. Qin and Qout [m3min-1] are the volumetric flows in and out of the tank. The level in the tank is given by h [m]. The flows are volumetric so it needs density term to convert from volume units to mass units. The cross-sectional area (A) of the tank must be known, so that we can determine the volume in the tank. Since there is no heating effect, the density can be assumed constant and since the tank is cylindrical, it has constant cross-sectional area [5].

$$A\,dh/dt = Qin - Qout \tag{1}$$

This equation describes the system behaviour and it is smooth enough to be linearized. It is a differential equation relating input flow rate *Qin* to the output level *h* where :
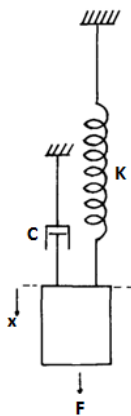
$$M\ddot{x} + c\dot{x} + kx = F \tag{2}$$

Fig 4. Level Analog to Mechanical

4.2. Analysis by Matlab

In case of 2lt with the specific gravity known 2.0 so M = 4 kg and also are known that c = 20 Nms, k = 30 N/m and F = 1 N, then the transfer function of an open loop would be :

$$\frac{1}{(4s^2 + 20s + 30)}$$

(3)
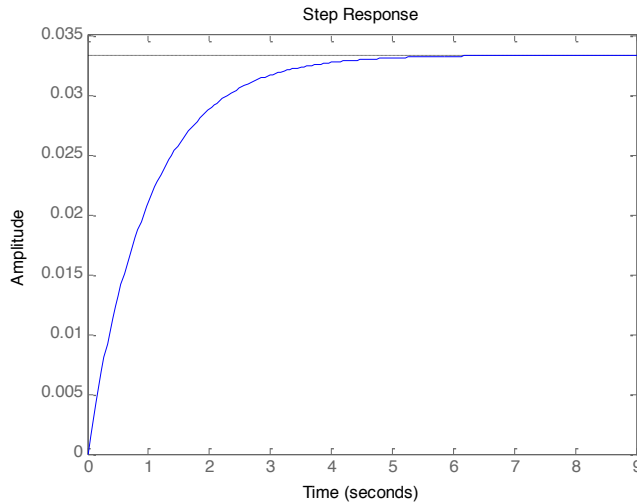
Fig 5. Open Loop Step Response

The step response of an open-loop with the gain 0.035 is quite large indeed. The rise time which is about 4 seconds and settling time 6 seconds are not good enough and too high especially for application in the industrial scale.

It is necessary to do tuning by introducing the close loop control and then start with using only P controller. For Kp = 250, the transfer function :

$$\frac{250}{30s + 280}$$

(4)

Fig 6. Step Response of P Controller

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By introducing P controller, it is able to reduce the rise time significantly but the steady state error is still quite big so it is necessary to try and add another controller to get the benefit of the combination of each controller.

By using PD controller at Kp = 240 and Kd = 10, the transfer function :
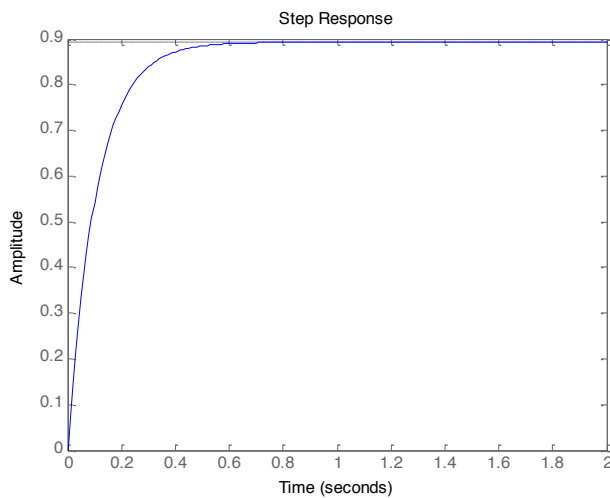
$$\frac{10s + 240}{40s + 270} \tag{5}$$
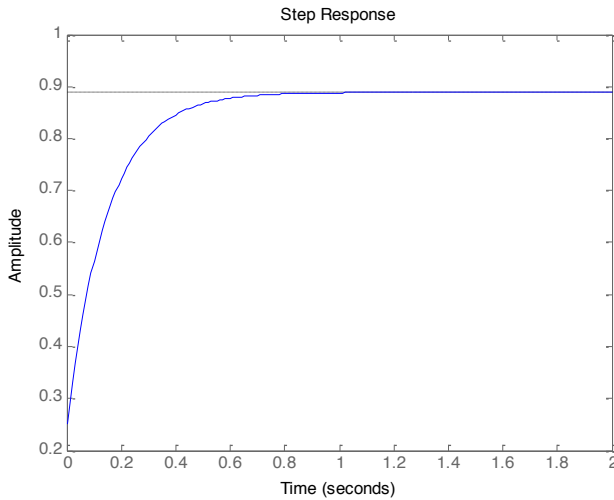
Fig 7. Step Response of PD Controller

PD controller turns out is not giving a significant effect as expected yet. Therefore it is necessary to introduce another controller which is the integral controller that will give double effect. For PI controller at Kp = 40 and Ki = 60, the transfer function :

$$\frac{40s + 60}{30s^2 + 70s + 60} \tag{6}$$
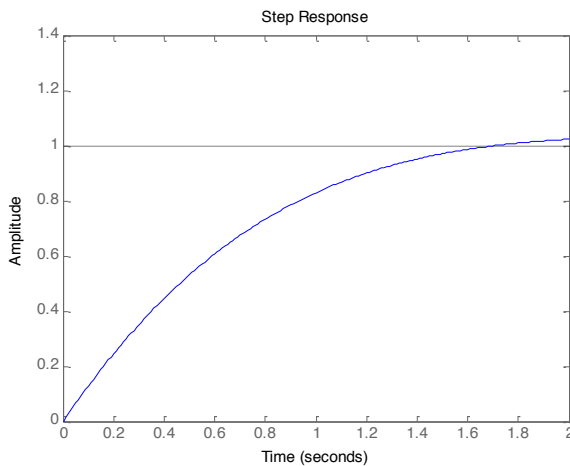
Fig 8. Step Response of PI Controller

From the step response, it is clear that the Integral controller is able to eliminate the steady-state error. Finally the PID controller is being introduced and after several trial and errrors, got the parameters at Kp = 600, Ki =500 and Kd = 100, and the transfer function is :

$$\frac{100s^2 + 600s + 500}{130s^2 + 630s + 500}$$

(7)

Fig 9. Step Response of PID Controller

By using PID controller, it is obtained the desired response with the best rise time, no overshoot and no steady-state error.

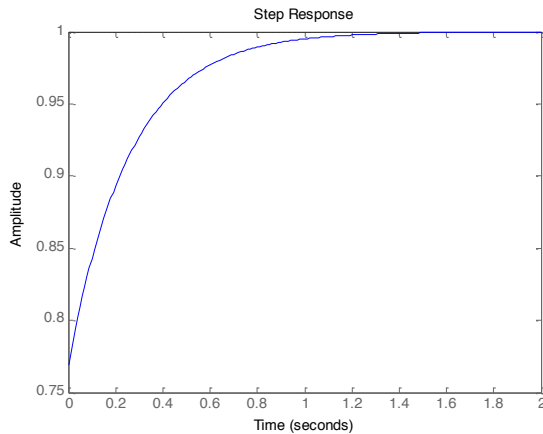| Table 1. Parameter	Kp	Kd	Ki	TF
P	250			$\dfrac{250}{30s + 280}$
PD	240	10		$\dfrac{10s + 240}{40s + 270}$
PI	40		60	$\dfrac{40s + 60}{30s^2 + 70s + 60}$
PID	600	500	100	$\dfrac{100s^2 + 600s + 500}{130s^2 + 630s + 500}$

5. Conclusion and Recommendation

After several trials with P controller and the combination of PD, PI and PID, the best result of output response is obtained by PID controller.   The controller could be well   tuned because mathematical models in s-domain are available.
It is recommended, when necessary, to study further on other algorithm such as fuzzy logic to get a higher control accuracy.

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Data Communication between Computers using MATLAB Program

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Abstract

This article does the research about data communication between computers using MATLAB program. The benefit of this research is we know how to create connections so communication between computers using Client and Server system based on MATLAB program. Data communication by using MATLAB program needs internet connection and known IP Address from client and server computers. Client can ask for data communication service, and Server can give information from data communication which Client asked. This research has succeeded for give information that step by step to build program using MATLAB in connecting between Computers with client and server system, and build the communication data.

Keywords: *MATLAB, Data communication, Client-Server*

1. Introduction

The science progress today is growing rapidly. Many research conducted in computer science field, from the simple application until various kind of complex application. Many computer networks that already open, it will make easier to exchange information digitally. Conventional methods would be even abandoned, because with the online connection many benefits that we can get like shorter time in the excahnge the information, and more economical.

Many ways to perform data communication, one common way is with client and server system. This common way system for calling database which Server will be share to Client. This research is done based on it, and do using program from MATLAB. And discuss how to build a Client and Server program using MATLAB language to succeed in doing data communication and create relationship Client and Server.

1.1. Client-Server

Client-Server can be defined as the ability of computer system to ask the services for request data from other Computer. Every instance is requesting the services referred to as a Client, while every instance providing the services referred to as a Server. With Client-Server system, user from various location can access the same data. So the architecture of Client –Server is the design of an application consists of client and server communicates with each other when accessing a server in a network.

Function Client-Server in the context of the data base, Client set interfaces serves as a workstation running a database application. Server receives user requests, check the syntax and generate in need of data base by using variation programming language.

1.2. Data Communication

So the notion of communication data can be interpreted a process of sending and receiving electronic data from two or more instruments are connected in a network via a media. So that, the data can be communicated from one place to another, needed third important elements that to be available,

that is data source, the transmission and receiver. Media transmission will bring data from the source to receiver.
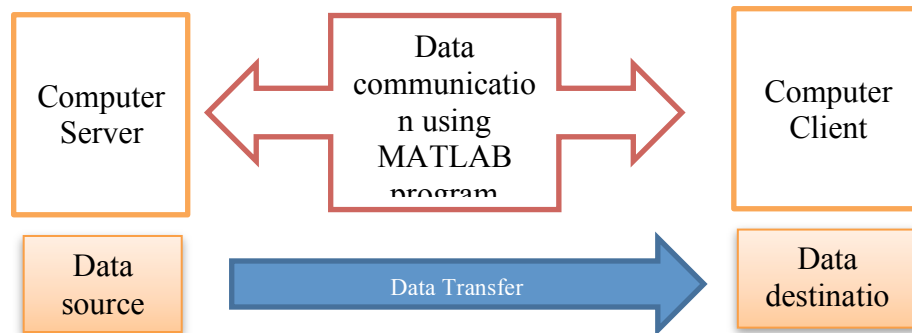
Figure 1. Communication illustration between the Computers

2. Research Methode

This research conducted with process as illustrated to following Flow chart (Fig.2). First step this research from development MATLAB programming until make the connection between two computers, and transfer data from Server computer to Client omputer.
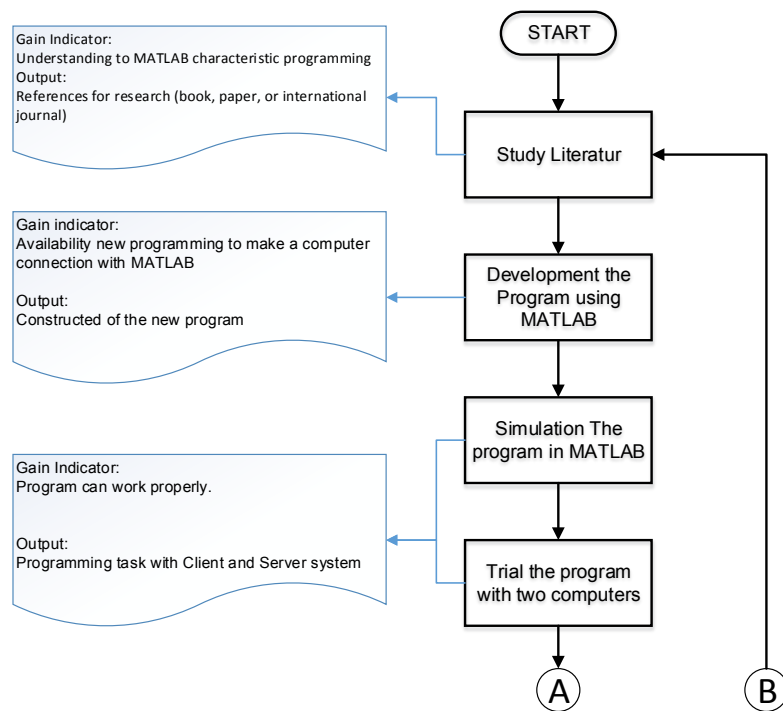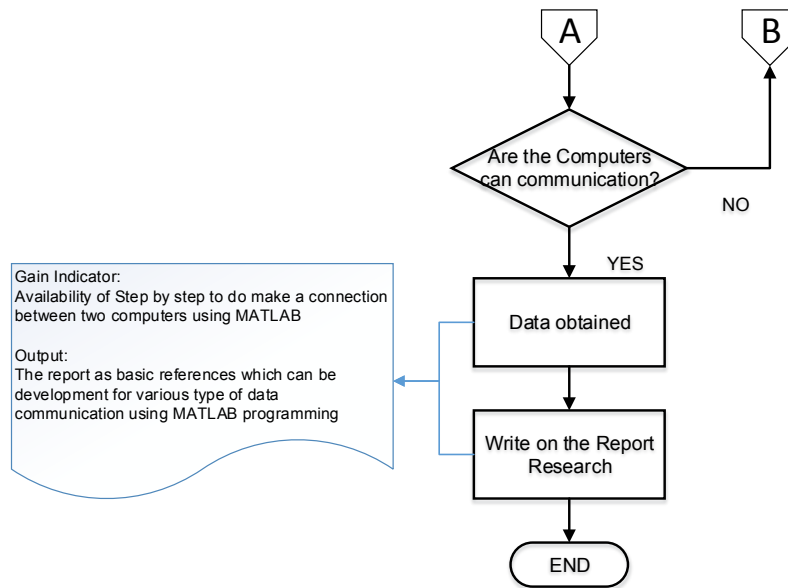
Figure 2. Flowchart research

3. Data communication with MATLAB programming

In this case we will transfer data image from Plot program MATLAB with Line Balancing project. The example Data can be viewed in Figure 3.
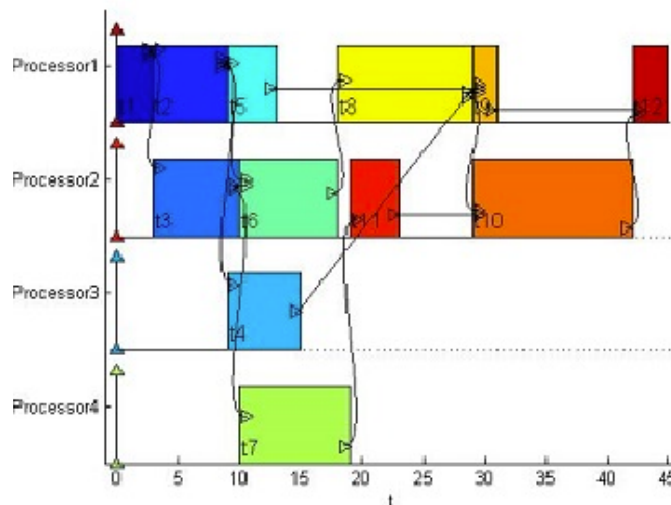
Figure 3. The Data will be transfer from Server to Client

Step in communicating Data between computer, first we must find IP address and Port available for Client computer and Server computer with help from command prompt. Having obtained the information in "Listening" mode from the IP address and port available, it will be used as the IP address and port of the Server and Client computers.
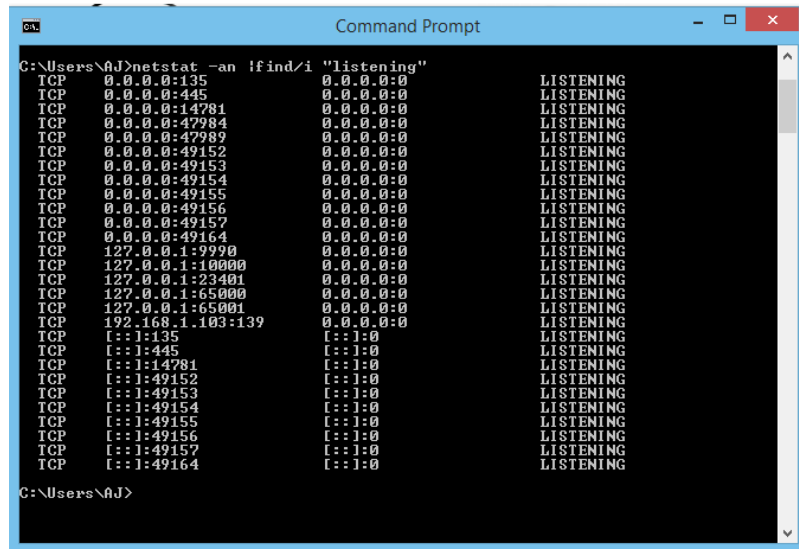
Figure 4. Command Prompt program in Computer, to get information of IP address and port available from the computers Client and Server in "LISTENING" mode.

3.1 Program Language in MATLAB application for Computer Server:

```
%===============
%SERVER PROGRAM%
%===============

clear all
close all
clc
data = imread('C:\Users\AJ\Documents\MATLAB\Balancing.jpg');
s = whos('data')
s.size
s.bytes
tcpipserver = tcpip('0.0.0.0',5500,'NetworkRole','Server')
set(tcpipserver,'OutputBufferSize', s.bytes);
fopen(tcpipserver)
fwrite(tcpipserver,data(:),'uint8');
```

3.2 Program Language in MATLAB application for Computer Client:

```
%===============
%CLIENT PROGRAM%
%===============

clear all
close all
clc

tcpipclient=tcpip('192.168.1.100',5500,'NetworkRole','Client')
set(tcpipclient,'InputBufferSize',307470);
set(tcpipclient,'Timeout',360);
fopen(tcpipclient);
rawData=fread(tcpipclient,307470,'double');
fclose(tcpipclient);
reshapedData = uint8(reshape(rawData,277,370,3));
imwrite(reshapedData,'D:\Data Paper Matlab\Linebalancing.jpg');
```

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Check the Established connection using the Command Prompt application of computer server and client before continuing the program, if the connection already established continue to run the program with Server program beforehand, and continued running the client program on another computer.
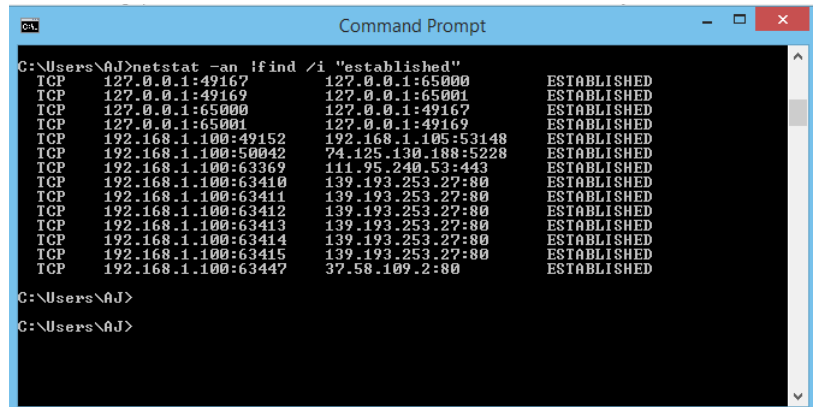
Figure 5. Check the ESTABLISHED connection with Command Prompt

Data communication can be done and the Client can pull data from the Server to provide information to the user, and it can be stored according to the destination directory.

4. Result of Research and Discussion

Data communication using MATLAB programs can be done with Client-Server system between computers. This method requires internet connection and has an IP address that remains, particularly for the Client. If there is interference on the Internet network, the processes of data communication between computers cannot be done.

The Server is not only serve requests from the client, but also can collect the information provided by the Client. In the process of data communications can be carried out according to the time required by the method of Real Time System. The following flow chart process of the research that has been done (see Figure.6):

```
                    ┌──────────┐
                    │   STAR   │
                    └──────────┘
                         │
        ┌────────────────────────────────┐
        │  Check IP Address and Port from │◄──────────┐
        │        Server computer          │           │
        └────────────────────────────────┘           │
                         │                            │
        ┌────────────────────────────────┐           │
        │  Write the Server Program in    │           │
        │  MATLAB from Server Computer    │           │
        └────────────────────────────────┘           │
                         │                            │
        ┌────────────────────────────────┐           │
        │  Write the Client Program in    │           │
        │  MATLAB from Client Computer    │           │
        └────────────────────────────────┘           │
                         │                            │
        ┌────────────────────────────────┐           │
        │ Check the Established connection │          │
        │      from Server Computer        │          │
        └────────────────────────────────┘           │
                         │                            │
        ┌────────────────────────────────┐           │
        │ Check the Established connection │          │
        │      from Client Computer        │          │
        └────────────────────────────────┘           │
                         │                            │
        ┌────────────────────────────────┐           │
        │  Run the Server Program in       │          │
        │  MATLAB from Server Computer     │          │
        └────────────────────────────────┘           │
                         │                            │
        ┌────────────────────────────────┐           │
        │  Run the Client Program in       │          │
        │  MATLAB from Client Computer     │          │
        └────────────────────────────────┘           │
                         │                            │
                    ◇ Is the Data can ◇── NO ─────────┘
                    ◇ be transferred? ◇
                         │
                        YES
                         │
        ┌────────────────────────────────┐
        │ Client get the Data from the     │
        │ Server, and will save in the     │
        │ directory from Client computer   │
        └────────────────────────────────┘
                         │
                    ┌──────────┐
                    │   END    │
                    └──────────┘
```
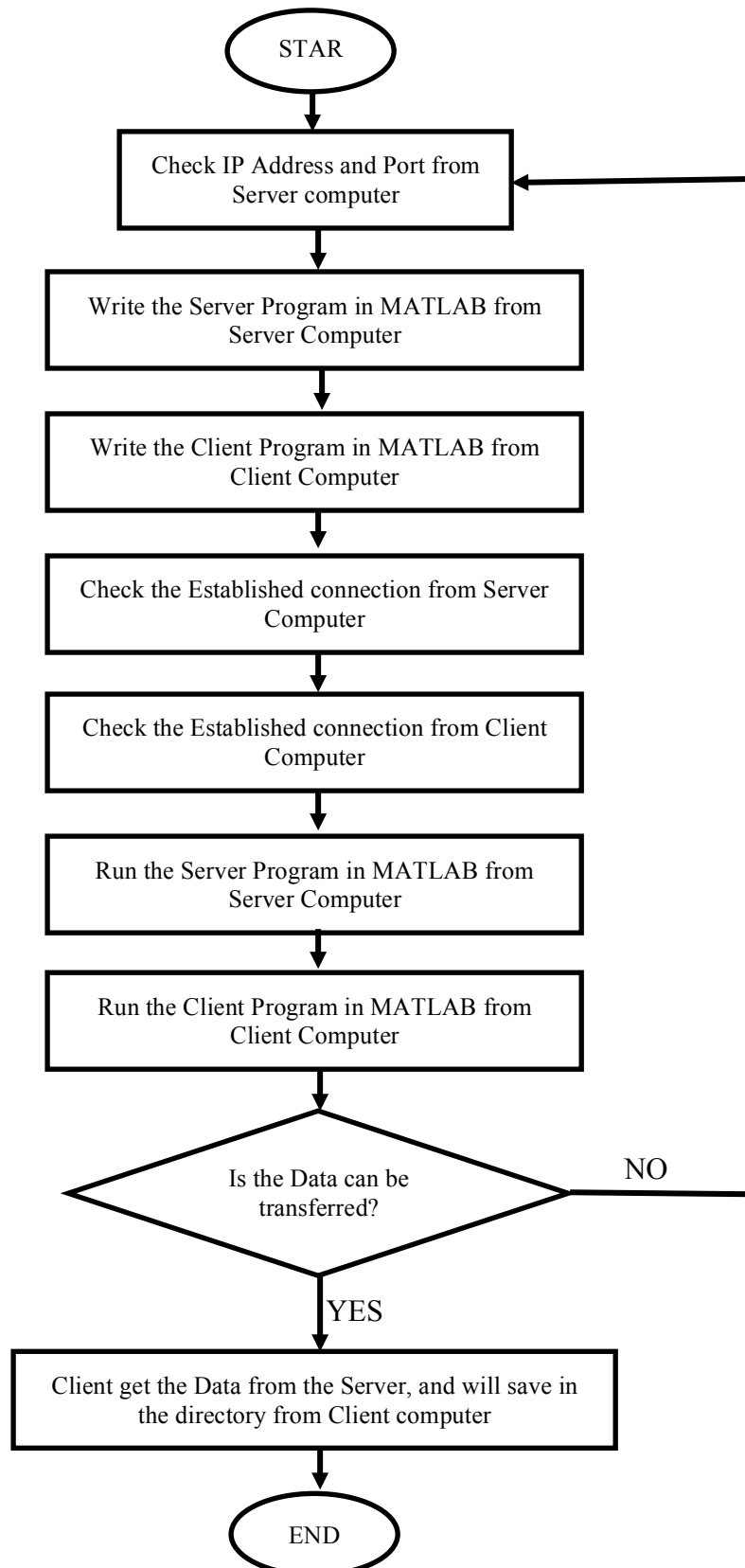
Figure 6. Flow chart connection with Client-Server method in MATLAB programming

5.   Conclusion

This research has been successfully done in the case of data communication between computers using the system Client-Server with the program and language in MATLAB. The Clients can pull the data from the Server to obtain information from data requested to the Server.

This research can be continued for a connection between a server with more than one client using MATLAB programs and data exchange with many methods like the Real Time System with data requests from the client to the server adjusted to the time required.

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The Annual Conference on Management and Information Technology (ACMIT) 2015

Fuzzy Controller Approach for DC Motor Control on Fishing Rod

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Abstract

In this paper described the usable and effectiveness of automation control by using fuzzy logic controller for controlling the speed of DC motor that will be used on string roller of fishing rod. The transfer function of DC motor has been obtained. For transfer function, the load of DC motor will be acted as input, and the output is the velocity of DC motor. The fuzzy rule base then created by trial and error. The step response between fuzzy logic controller and without using fuzzy logic controller then obtained and compared. As a result, the fuzzy logic has successfully reduced the overshoot of step response.

Keywords: fuzzy logic; dc motor; fuzzy rule base

1. Introduction

Fuzzy logic control surely has its most interesting point as it can attracted most attention. Recently, fuzzy logic control has found many applications in the past decade. This is so largely because fuzzy logic control has the capability to control uncertain, nonlinear systems. It also has capability to control the system when there is no availability of mathematical model. A fuzzy logic controller makes control decisions by using IF-THEN rules. This controller can be divided into two types: Mamdani type and Sugeno type. Mamdani-type FLC uses fuzzy number to make decisions. Sugeno-type FLC uses linear function of input variable to generate control actions. Composition rule of interference[1,2] and its variants[3-5], that lead by Zadeh, analogy and similarity, and interpolation analysis of fuzzy reasoning, are the references as main ideas for various fuzzy methods. A fuzzy logic controller can be regarded as a real-time expert system that employs fuzzy logic to manipulate qualitative variables. Fuzzy logic control is a control algorithm based on a linguistic control strategy, which is derived from pro knowledge directly into an automatic computerized control. Fuzzy logic control doesn't need any tough precise calculations like the others control system. The idea simply employs uncomplicated precise calculations to help mimic the expert knowledge, while the others control system use difficult mathematical calculation to provide a model of the controlled plant. Although it doesn't need any difficult mathematical calculation, however it will provide effective and good performance in a control system. For this reason, it can be one of the best offered answers today for a wide class of challenging controls issues. On the case of DC motor, many varieties for speed control have been developed, such as proportional (P), proportional integral (PI), proportional derivative integral (PID), adaptive and fuzzy logic controller (FLCs) have been developed for speed control of DC motors [6-9].

1.1. Objectives

The objectives of this research is to analyze the effectiveness of fuzzy logic control that will be used to control the velocity of DC motor on string roller of fishing rod. The effectiveness is measured based on comparison of overshoot, rise time, and settling time between fuzzy logic and non-fuzzy logic.

1.2. Limitation of Research

Because of its non-linearity of DC motor based on load, the maximum load of the DC motor will be limited until 10 kilograms.

2. Literature Review

This section will discuss about model of DC motor that can be found on many literature. And also the equivalent mathematical model of this DC motor

2.1. DC Motor Mathematical Model

DC motors are very highly reliable and flexible because of its good behaviors, like high starting torque, linearity control, and efficient response. DC motors are very suitable for wide range of speed control and adjustable speed drive.
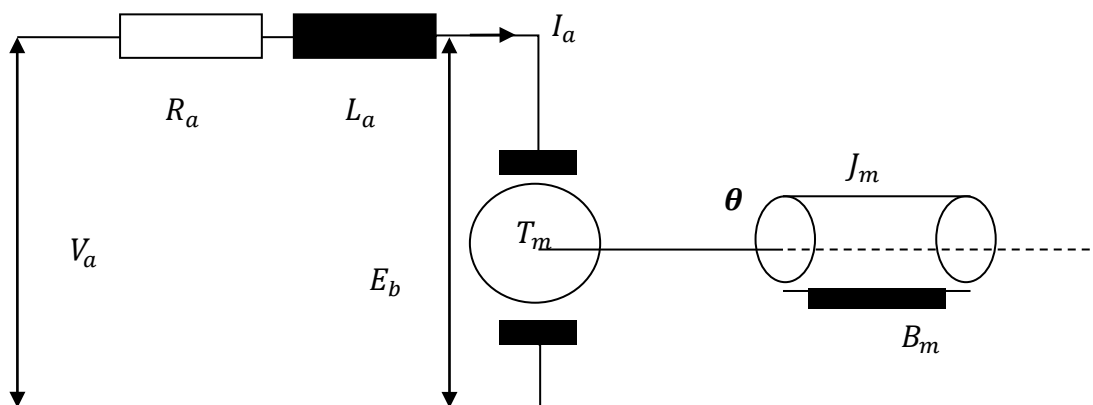

Figure 1 DC Motor Model

The figure 1 shows a DC motor equivalent model. Relevant system equations are:

$$v_a = R_a i_a + L_a \frac{di_a}{dt} + e_m \qquad (1)$$

$$e_m = K_e \dot{\theta}_m \qquad (2)$$

$$T = K_t i_a \qquad (3)$$

$$T = I_m \ddot{\theta}_m + b \dot{\theta}_m \qquad (4)$$

Where V_a = applied voltage
       e_m = motor back emf
       K_t = motor torque constant
       I_m = equivalent moment of inertia reflected at the motor shaft
       b   = equivalent viscous coefficient reflected at the motor shaft
       I_a = armature current
       K_e = motor voltage constant
       T   = torque generated by motor

The obtained transfer function:

$$\frac{\omega(s)}{V(s)} = \frac{Km}{(Js+b)*(L_m s + R_m) + K_m{}^2)} \tag{5}$$
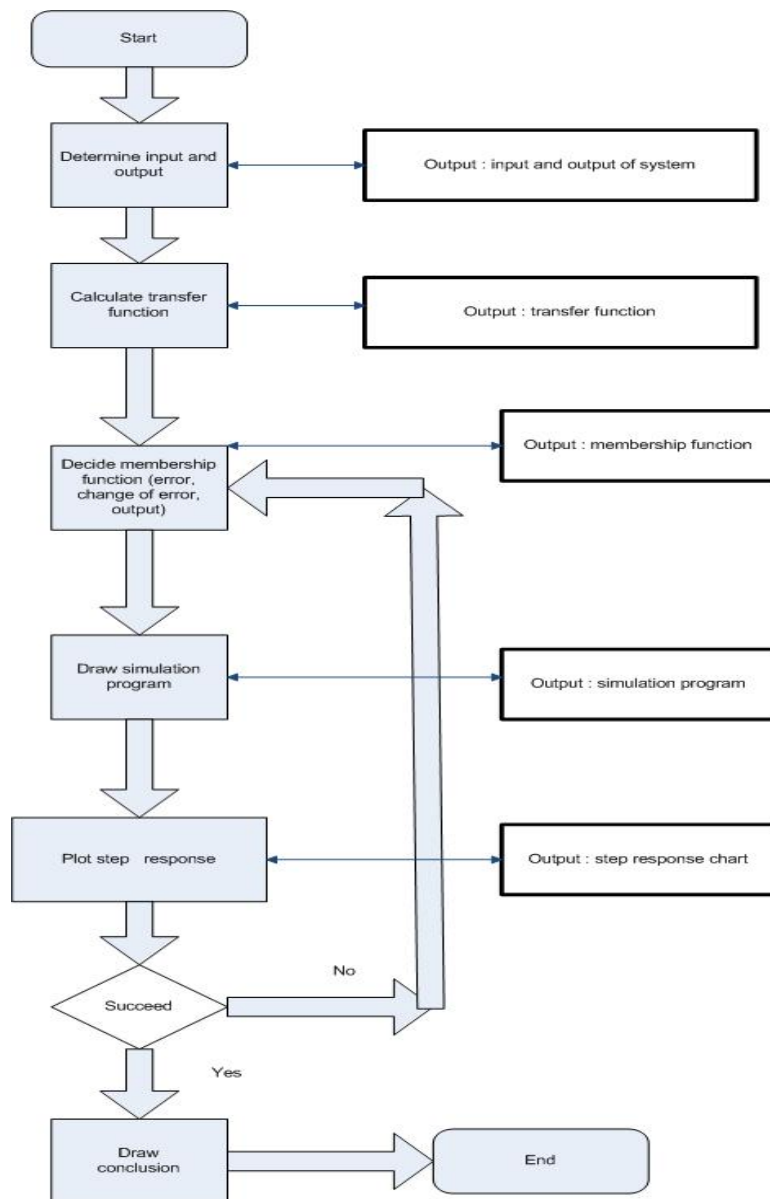
3. Research Flowchart

Figure 2 Research Flowchart

For the flowchart of this paper, first the input and output of the system must be determined. After that, the transfer function must be calculated. By using trial and error, the membership function for

each input and output must be determined. Simulation program then used to simulate the result. The membership function and rule must be redrawing again if the result didn't satisfied.

4. Result and Discussion

The base of fuzzy logic is from the simulation of people's opinions and perceptions to control any system. Fuzzy logic control is constructed on logical relationships that can be understood by human. The words like "very small, small, medium, little medium, large, very large" is commonly used as logical relationships. There is a strong relationship between fuzzy logic and fuzzy set theory, which is similar to Boolean logic. The generic algorithm for fuzzy logic control can be designed as follows:

A. Fuzzification
   a) Normalize universes of discourses for the fuzzy input and output vector
   b) Convert crisp data into fuzzy data or membership function
   c) Calculate the membership function for every crisp value of the fuzzy input
B. Fuzzy Inference
   d) Combine membership function with the rule to drive the fuzzy output
   e) Calculate membership function for every crisp value of the fuzzy input
C. Defuzzification
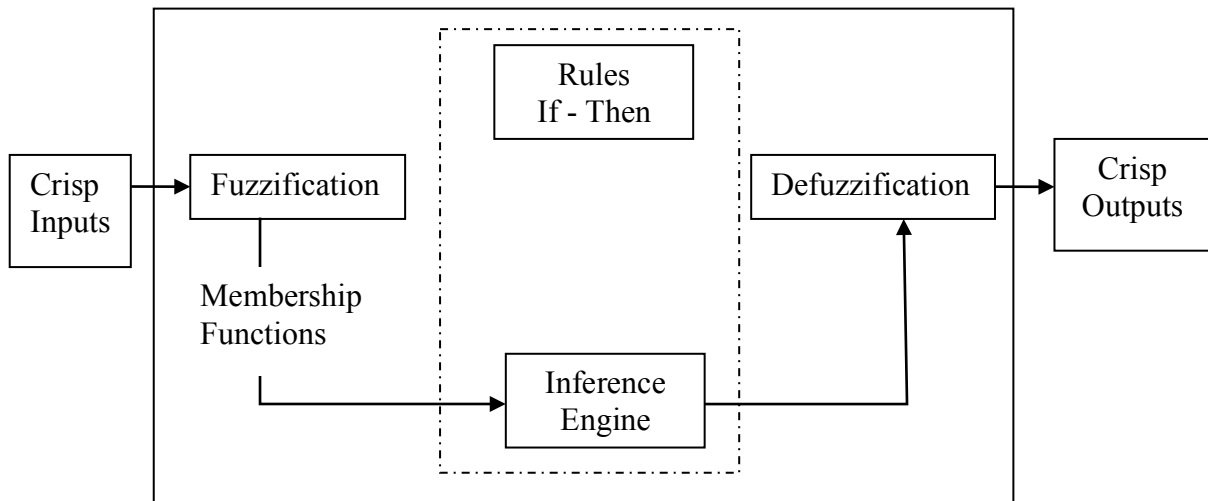   f) Calculate fuzzy output, using defuzzification method

Figure 3 Fuzzy Controller Block Diagram

The DC motor that will be used must has high toque and high density. The specifications for this research includes as follow:

Parameter	Unit
Size	Shaft Size 3.175mm
	Diameter : 36 mm
	Length : 53 mm
Normal voltage	7.2 V
No Load Speed	12500 rpm
No Load Current	1.8 A
Commutation	Carbon Brush
Weight	162 g

Table 1 DC Motor parameter

Based on the parameter, the transfer function for this DC motor has been obtained as:

$$\frac{1}{0.005\,s^2 + 0.06\,s + 7.3} \tag{6}$$

The step response of open loop control system for the transfer function showed as below:
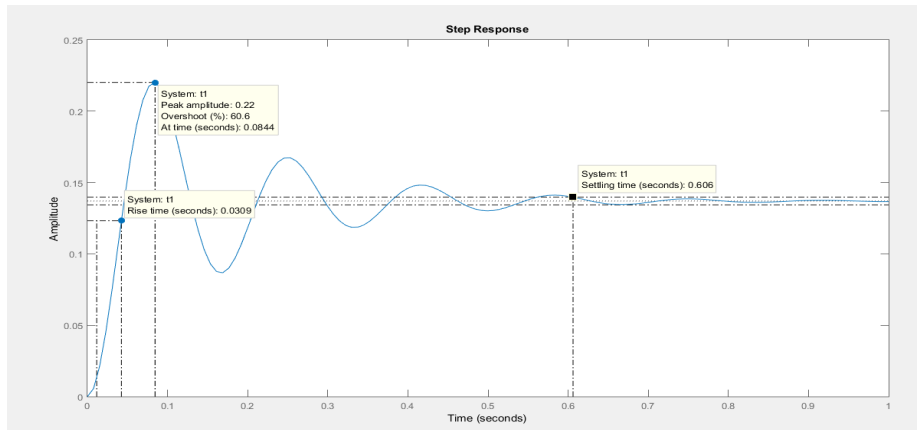

Figure 4 Step Response

Figure 4 above shows that the rise time is on 0.0309 seconds overshoot about 60 %, and settling time about 0.606 seconds. This open loop control system didn't meet the minimum requirement for the system.

The five linguistic variables are used in this work, which contains NB, NS, Z, PS, and PB. They represent Negative Big, Negative Small, Zero, Positive Small, Positive Big, respectively. The rule base table for fuzzy logic is shown as below.

CE \ E	NB	NS	Z	PS	PB
NB	NB	NB	NS	NS	Z
NS	NB	NS	NS	Z	PS
Z	NS	NS	Z	PS	PS
PS	NS	Z	PS	PS	PB
PM	Z	PS	PS	PB	PB

Table 2 Fuzzy rule base

Membership functions for fuzzy logic inference have been applied as follows:
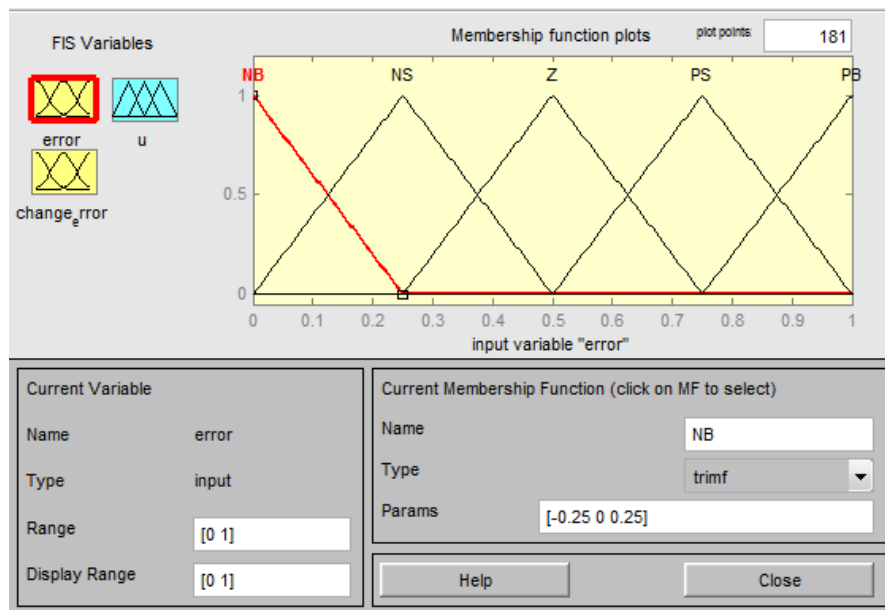

Figure 5 Membership Function for error

Figure 5 above shows membership function of error, which calculated from the delta between set point and result point. Membership function of error contains NB, NS, Z, PS, PB which represent Negative Big, Negative Small, Zero, Positive Small, Positive Big, respectively.
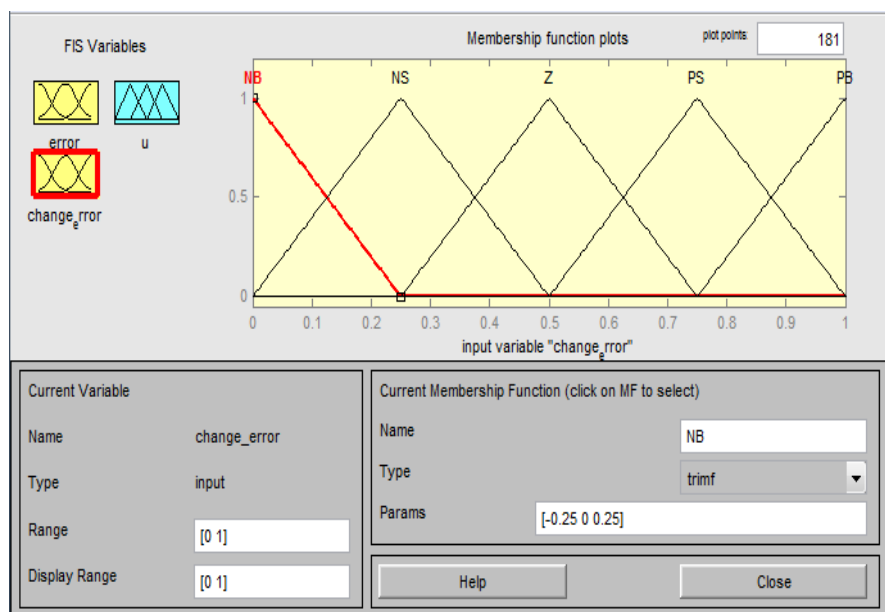

Figure 6 Membership function for change of error

Figure 6 above shows membership function of change error, which calculated from delta of past error and current error. Membership function of change error also contains NB, NS, Z, PS, PB which represent Negative Big, Negative Small, Zero, Positive Small, Positive Big, respectively.
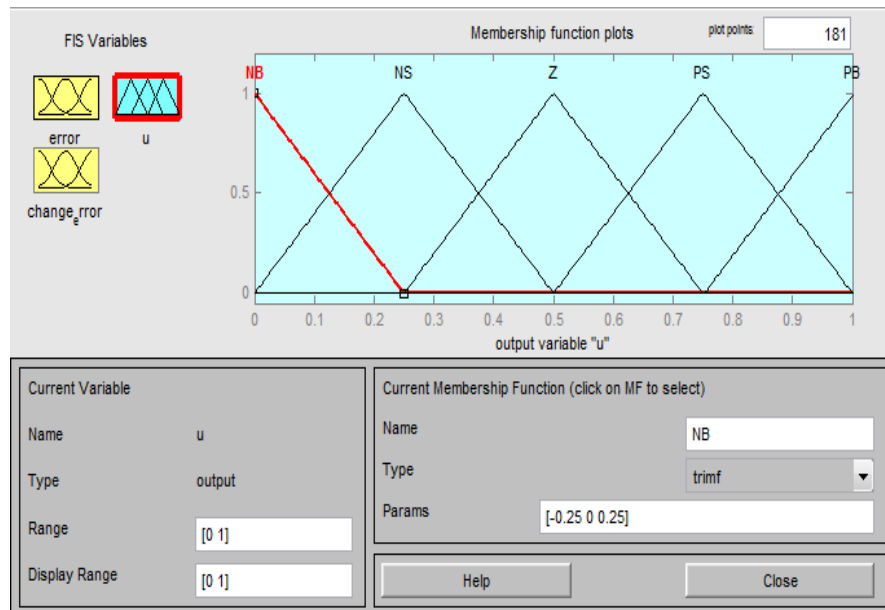
Figure 7 Membership function of output

Figure 7 above shows membership function of output, which represent the result of speed that needed in order to rotate the string roller. Membership function of output also contains NB, NS, Z, PS, PB which represent Negative Big, Negative Small, Zero, Positive Small, Positive Big, respectively.

Figure 5, 6, 7 show the membership function plots of error, change of error, and output based on fuzzy rules base that has been created before, respectively.

The control surface that produced on MATLAB software based on these rules shown as below:
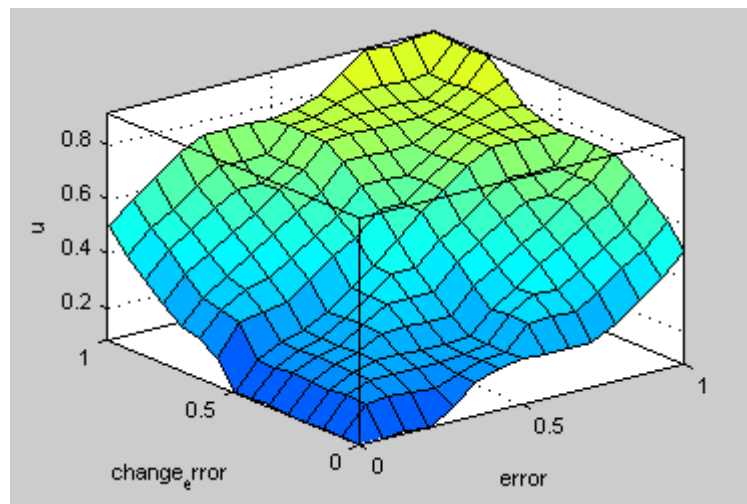

Figure 8 Control surface

Figure 8 above shows control surface that represents the smoothness of new control system that has been developed.

By using Matlab software, the simulation of fuzzy logic control has been designed as follows:
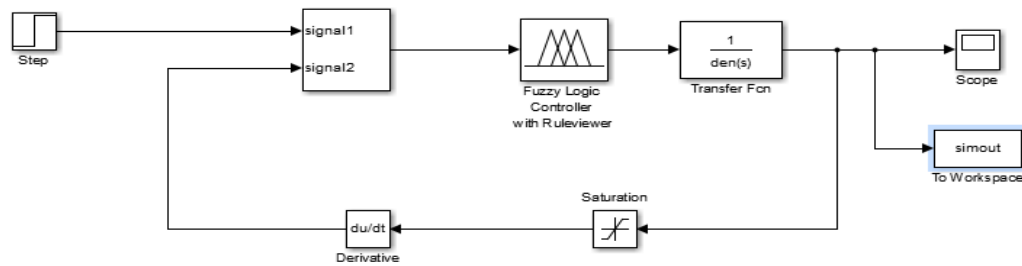

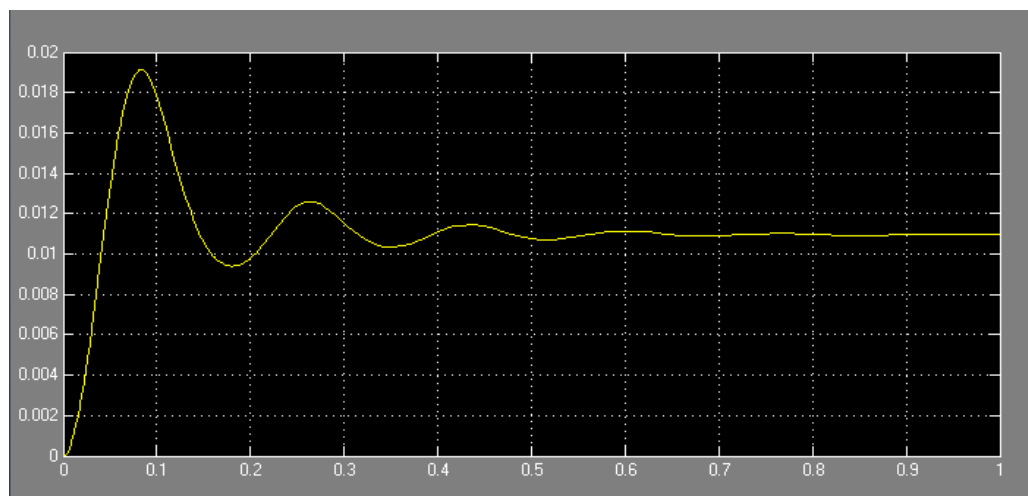Figure 9 Fuzzy Logic Simulation Diagram

Figure 10 Step Response Fuzzy Logic

Figure 10 shows the step response from closed loop control system based by using fuzzy logic control. Based on the step response, the rise time is on 0.7 seconds, overshoot: 19.5876 %, settling time: 0.8 seconds.

5. Conclusions

Using MATLAB software, the mathematical model for DC motor has been obtained. First, a rule of fuzzy logic was created and implemented. Then, the step response of closed loop and open loop control system was compared. Without controller, the step response has overshoot that cannot satisfy the system requirements. Without using fuzzy logic, the overshoot on open loop control system can reach 60.6%. By using fuzzy logic controller, it can handle the overshoot. The simulation from closed loop control system by using fuzzy logic control has succeeded to reduce the overshoot to 19.58%. For next improvement, the author suggests improvement on fuzzy rule base table so it can run more smoothly.

Acknowledgements

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Light Dependence Resistor Used as a Sensor for a Solar Tracker

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Abstract

This research focuses on a sensor that is suitable for solar tracking. In tracking system, solar panel harvests energy optimally if the panel surface position is perpendicular to the light direction. To constructs mechatronic system, the selection of sensor is very important. Datasheet is helpful for pre selection. Further research has been carried out to determine the specific sensor which will be mounted into electronic circuit. Based on the experiment on selected sensor, sensor characteristic is obtained in detail. Sensor output is processed in the microprocessor. At the end, an actuator has a task to swap desired mechanical movement which is instructed by controller. Actuator must fulfill technical requirements, such as load, speed, durability, price, availability and maintenance aspect. This paper gives an overview to answer this problem.

Keywords: Sensor, LDR, Solar Tracker;

1. Introduction

To select an appropriate sensor for a mechatronic system design is very challenging. The selection upon a huge choice of sensor types and specification offered in the market need guidance. The purpose of this paper is to guide the selection step choosing sensor. That sensor is being applied in the solar tracking system. As guidance, selection process is referring to designed flowchart. From the flowchart, it comes up to the selected sensor.

This paper focuses into a sensor, which is able to detect light intensity. Some electronic components can sense the light intensity. One of them is Light Dependence Resistor (LDR). An experiment is made to the specified selected sensor, with the specification LDR GL 5528. The experiment is conducted as follows. Piece of LDR treated with four difference light intensity. A characteristic is resulted from the experiment. Based on the result, then further decision and design of signal processing is developed. The whole construction is a solar tracking system. But this paper only discusses about LDR.

To make the system real, a miniature construction is built. The miniature is a scaled project with scale down 5:1 size. By constructing the miniature, sensor and actuator are examined frequently to simulate the function optimally. To give an overview about the mechatronic design, see Figure 1: Illustration of Construction Design.

For mechatronic system, sensor, controller and actuator are applied to set the desired position. The sensing value is sent to the controller; whereby microcontroller controls the position of the roof refer to the direction of the Sun shine. The construction is an array of photovoltaic module and supported by steel frame in form rectangular. The middle of one side is supported underneath with axle as an axis, whereby the roof will be able to swing freely.

The whole construction is subjected into two main purposes. Firstly, this is as a port or garage and secondly as an electrical home power supply system. The construction design must accommodate the both purposes. Due to the constraint of using as garage roof, the tracking angle is laid between plus and minus 30 degrees to horizontal.
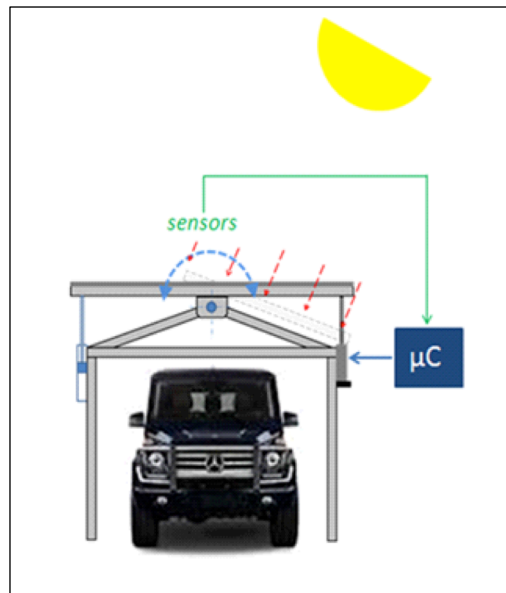
Figure 1: Illustration of Construction Design.

2. Previous Research

This paper is referring to previous research, A Design of Single Axis Sun Tracking System [1]. Sensor takes very significant role for further process in mechatronic construction. In spite of sensor, there is a room to discuss. The previous paper does not discuss about sensor in deep. Therefore, it is a chance to discuss about choosing of LDR in this paper.

In Input Process Output concept (IPO), output is depended on all inputs which are processed by the processor. The best output is only resulted from the right input. In the other hand spread of sensor characteristic is very wide.

LDR stands for Light Dependent Resistance. It is often named as Photo resistor and made of semiconductor cadmium sulphide. This semiconductor is very sensitive to light and irradiation of light. LDR has highest resistance in the dark light and its resistance varies inversely to the light intensity occurred. It works due to dissolution bond in the semiconductor by light irradiation. Electronically it used as variable resistor in the circuit. It regulates voltage drop to be trigger of transistor, switch or relay.

Available datasheet is as reference [2]. The datasheet informs user about: package dimensions, absolute maximum rating, and electro-optical characteristic. Absolute maximum ratings give the parameter continuous dissipation above 25º C and temperature range operating and storage. Electro-optical characteristics @ 25º C cover part number, resistance value, material type, sensitivity, maximum voltage and response time.

3. Method

Following flowchart (Figure 2: Sensor Selection Guideline Flowchart) is a guidance to determine appropriate sensor. The process consists of 5 (five steps).

Step 1, pay a particular attention on input type or often called as stimulus. It is clear guide to think about, what kind of stimulus will be measured? In this case, the stimulus is light intensity. From the first step type of stimulus light intensity is as gain.

Step 2, as stimulus defined correctly, following question should be answered. What kind of sensor or electronic component is appropriate to sense? In this case, if the stimulus is light intensity, the electronic parts which are able to differentiate light intensity are LDR (Light Dependent Resistor), LED (Light Emitting Diode) and PV (Photo Voltaic). It means these three electronic parts are nominated as sensor for the system design. The output from second step is the type of component which is able to sense light intensity: LDR, LED or PV.

Step 3 is deeper study about characteristic of each type of sensor. What happen if deference light intensity occurs to these components? LDR as a sensor is characterizing as variable resistance and need power supply. LED and PV is assuming as battery power supply. Other characteristic should be taken

as references are sensitivity, accuracy, span and range. The output from this step is experiment result from selected sensor.

Step 4 is "Does the selected sensor fulfil most basic requirement?" requirements of the project. Technical datasheet is very helpful to focus on selected sensor and examine with further experiments and treatments on it. The outcome of this step is selected type of sensor.

Step 5 is more end design, how the installation from the sensor is completed with the power supply into processor will be realized. The wiring must be clear designed. The feasibility of space must be considered. The environment disturbance must be minimized. The outcome from this last step is compact aggregate of sensor. It is consisting of sensor module which is ready to feed the sensing value to the processor. See Figure 2: Sensor Selection Guideline Flowchart as reference.

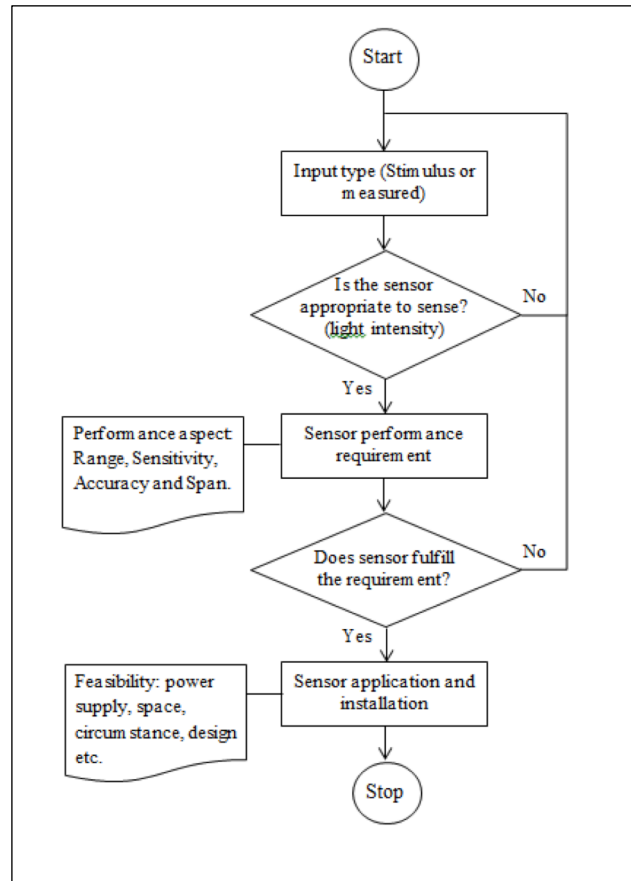Figure 2: Sensor Selection Guideline Flowchart

4. Result of the Research and Discussion

An experiment is conducted to piece of LDR GL 5528 with deference light intensity. The result is in the following Table 1: Light Intensity vs Resistance of LDR.

Electronic Part	: LDR
Type	: GL 5528
Measuring Tool	: Fluke 289
Unit	: Ω
Numbers of Piece	: 15 pieces

Below is Table 1: Light Intensity vs. Resistance of LDR Type GL 5528.

Nos.	Resistance Value in Ω (Ohm) under light intensity of				Notes
	Dark (0 lux)	Indoor (220 lux)	Blocked (490 lux)	Sunlight (1200 lux)	
1	60,430	5,130	310	99	
2	59,820	4,831	321	85	
3	62,130	4,800	348	111	Highest
4	52,934	4,835	383	125	Highest
5	40,077	4,664	366	95	
6	42,470	5,370	327	114	
7	53,923	5,101	422	119	
8	42,380	4,570	298	90	
9	52,540	5,321	247	83	
10	34,260	4,422	281	107	Lowest
11	61,500	5,507	362	108	
12	61,830	4,516	348	80	
13	48,495	4,913	224	114	
14	48,424	5,126	361	62	Lowest
15	46,207	6,120	340	105	
Avg.	51,161	5,015	329	100	

Above table is obtained from experiment. Resistance value of Light Dependent Resistance under certain light intensity treatment is measured. The treatments are darkness, indoor, direct and indirect sunlight. Average value from each treatment is calculated to have the variance of each component. It is important to select an appropriate individual part.

From experiment toward 15 components, the average resistance value is:
- 51.161 Ω (Ohm) for dark light,
- 5.015 Ω (Ohm) for indoor,
- 329 Ω (Ohm) for blocked sunlight with an object and
- 100 Ω (Ohm) for direct sun light intensity.

In the dark light, the variance of resistance is from 34 kΩ to 62 kΩ, or equal to 28 kΩ. It means the part, number 3 and 10 are not close to the specification. It is not recommended to choose. For the resistance value with indoor treatment, the variance is 4,7 kΩ to 6,1 kΩ or equal to 1,4 kΩ. For blocked treatment, the average value is 329 Ω and for direct sunlight the average value is 100 Ω. With the above result, we have to consider for next design.

Based on the experiment value, below is the electronic wiring design. The input design is a voltage divider concept varies with the resistance value into microcontroller. Voltage divider is an connection arrangement is in series. The connection then powered with V in, e.g. 5 volt. One resistance value is fixed. The other resistor is LDR. Since the resistance value is vary, the V out will vary as well.

A pair of LDRs is seated next to the other and separated by a partition. If light does not come perpendicularly to this set of LDR, the intensity of receive light will be difference and impacts the resistance value. The resistance blocks proportionally power supply to controller which is read as an input. In the night, both sensors detect no light and have maximum resistance.

To get a whole perception of the system, following short overview about recommended actuator and microcontroller is described.

The basic principle of deference light intensity is using a pair of LDR as shown in Figure 3: Voltage Divider Configuration Using of LDR [3].
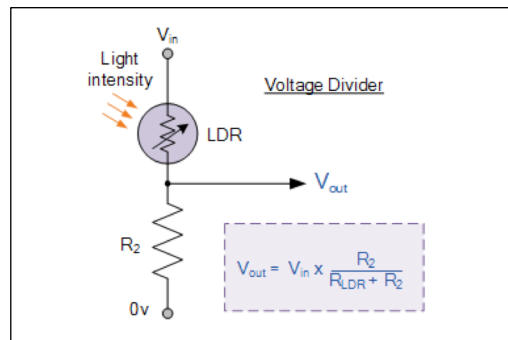
Figure 3: Voltage Divider Configuration Using of LDR

An aggregate of DC-motor with linear motion is used as an actuator. A DC-motor has advantages, e.g. powerful, vice versa direction and direct current. Mechanical damper is used to reinforcing and damping again the disturbance force.

Refer to the construction design and prerequisite a Linear DC motor, Figure 4: Linear DC Motor is chosen to be experimented.

Figure 4: Linear DC Motor

Specification of Linear DC Motor Geotrack TD 18 [4]
    Model   : TD 18, Regular Actuator
    Power supply   : 12 - 36 DC Volt
    Load Capacity   : 3.000 N
    Static Load   : 4.500 N
    Sensor   : Reed limit switch
    Stroke   : 18 Inches (about 450 mm)
    Temperature   : -26º C to 65º C (-15º F to 150ºF)

Linear DC Motor Geotrack type TD 18 performs a reliable value for the purpose. The Motor is intended for solar tracking with low speed (30 RPM), appropriate DC power supply from 12 to 36 volt, low current even with 0,5 Ampere and reliable for outdoor.

The sensing values from the sensor are processed with microcontroller. It is recommended using of Arduino as controller. Arduino is worldwide open source, compactible and practice [5]. The average value of LDR1 and LDR2, after certain times reading will be taken by microcontroller. Based on it, microcontroller controls the motor to move till the value is in the range. Following is the simple input output diagram.
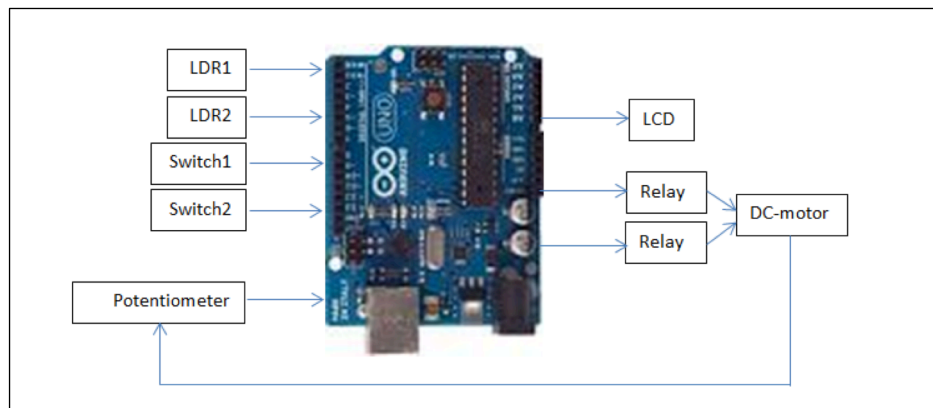
Figure 5: Arduino Uno with I/O

Since the motor work with 12 volt DC, relay (Relay1 and Relay2) are used. Relay connected to get the outputs processed by microcontroller. Development of software to control the hardware is attached. As illustration see Figure 5: Arduino Uno with I/O.

5. Conclusions

In the wide range of choice, it is necessary to find sensor properly. From the guidance step, it can be concluded as follows:
- Electronic datasheet is very helpful for us to be focus in the desired data specification. But it is still an experiment needed for the characteristic detail.
- The chosen sensor LDR GL 5528 characteristic has been experimented for further design. And LDR GL 5528 is suitable as sensor for solar tracking purpose.
- LDR stands for Light Dependent Resistance. It is made of semiconductor Cadmium Sulfide. This semiconductor is very sensitive to light and irradiation of light. LDR has highest resistance in the dark light and its resistance varies inversely to the light intensity occurred.

The sensing value is processed into controller with the fundamental of electronic wiring design. Electronically it used as variable resistor in the circuit. It regulates voltage drop to be trigger of transistor, switch or relay.

Based on the IPO concept, the input prerequisite is done. Further research is to determine an actuator and to design a microcontroller for solar tracking system. Geotrack TD18 is recommended as actuator. The DC linear motor is reliable for the requirements, such as load, speed and response time. To process sensing value, Arduino platform is also good choice to be studied in connection with solar tracking system.

Acknowledgements

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Real-Time System for Sending Data from Three Clients to One Server with MATLAB

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Abstract

The real-time system is now used on many fields, such as telecommunication, military, information system, even medical to get information quickly, on time and accurate. Needless to say, a real-time system will always consider the performance time. In our application, we define the time target/deadline, so that the system should execute the whole tasks under predefined deadline. However, if the system failed to finish the tasks, it will lead to fatal failure. In other words, if the system cannot be executed on time, it will affect the subsequent tasks. In this paper, we propose a real-time system for sending data to find effectiveness and efficiency. Sending data process will be constructed in MATLAB and sending data process has a time target as when data will send.

Keywords: Real-time system, Client, Server, MATLAB

1. Introduction

The development of the technology in the world is rapidly and has an impact on human life. Technology most used by humans is the computer which can be used to manage information, communication, research etc. With high advancement of computer technology, using real-time system is very influential especially for human life. For example, transfer money, sending confidential data from a military base, social networking, geography etc. Logically if everything conducted with a real-time system then the work can be done effectively and efficiently.
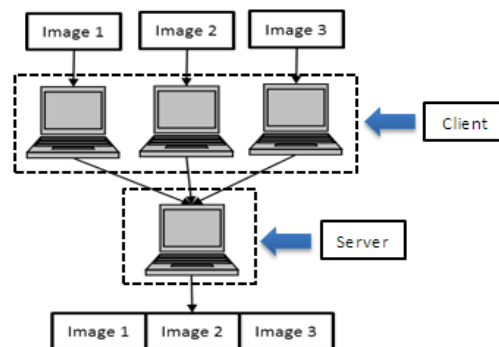
Figure 1: Design simulation real-time system

In this research as figure 1 we will do simulation to send data with real-time system, there client and server. We used MATLAB software for communicating between computers and used communication via internet to build a real-time system. Sender the data was called the client, there are 3 units while the data receiver was called server only 1 unit. Each client has different data and time for delivery. The data was sent in the form of pieces of the picture. If it is time then each client will send its data then the task's server will receive all the data and then combine that data into a single data. The server will be display a single data as predetermined time.

1.1. Objectives

Thus the purpose of this research is to making simulation to sending data with use real-time system that effective and efficient. Effective is on time and efficient is a low cost, so the on time delivery in accordance with the time target and low operating costs, does not require manpower to operate it or not monitor the system every time.

1.2. Limitation of Research

In thus research, we focus delivery data must be on time as time target that we have define before.

2. Real Time system

Real-time systems are computing systems that have a time to execute the system and the time must be precise to events in the environment. As a consequence, the correct behavior of these systems depends not only on the logical result of the computation but also on the time at which the results are produced. A reaction that occurs too late could be useless or even dangerous. Examples of applications that require real-time computing include:

- Chemical and nuclear plant control.
- Railway switching systems,
- Automotive applications,
- Flight control systems,
- Telecommunication systems,
- Industrial automation,
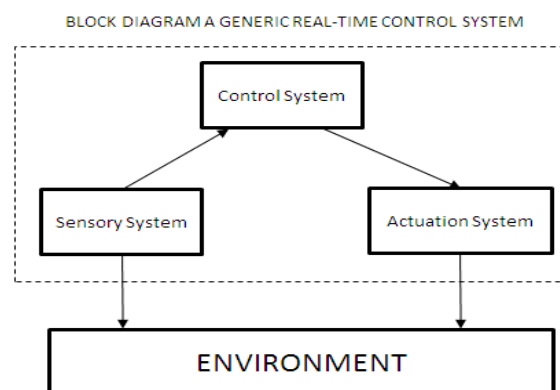- Robotics,
- Military,
- Space missions, and

Figure 2: Block diagram generic real-time control system

Following Figure 2 is a block diagram of real-time control system. Sensory system gets the data from the environment such as; temp, weather, height, length etc. Then sent all information with on time to control system to be processed then control system send command with on time to actuation system works.

3. Soft and Hard Real-time System

At the process level, the main difference between a real-time and a non- real time task is that a real-time task is characterized by a deadline, which is the maximum time within which it must complete its execution. In critical applications, a result produced after the deadline is not only late but wrong. Depending on the consequences that may occur because of a missed deadline, real-time tasks are usually distinguished in two classes, hard and soft.

A real-time task is said to be hard if missing its deadline may cause catastrophic consequences on the environment under control. Example of this system is a system shutdown from a rocket. An unexpected delay for half a second may cause the rocket to explode. A real-time task is said to be soft if meeting its deadline is desirable for performance reasons, but missing its deadline does not cause serious damage to

the environment and does not jeopardize correct system behavior. Example of that system is a video player that should always displays each frame in accordance with the desired rate. For a half second delay will not cause a fatal failure, but it will interfere with the user.

4. Research Methodology

For realization a real-system that we propose in this article (figure. 2) , we compose the flowchart of research as shown in the following figure 3. In this research, we divided three step and every step has a goal.
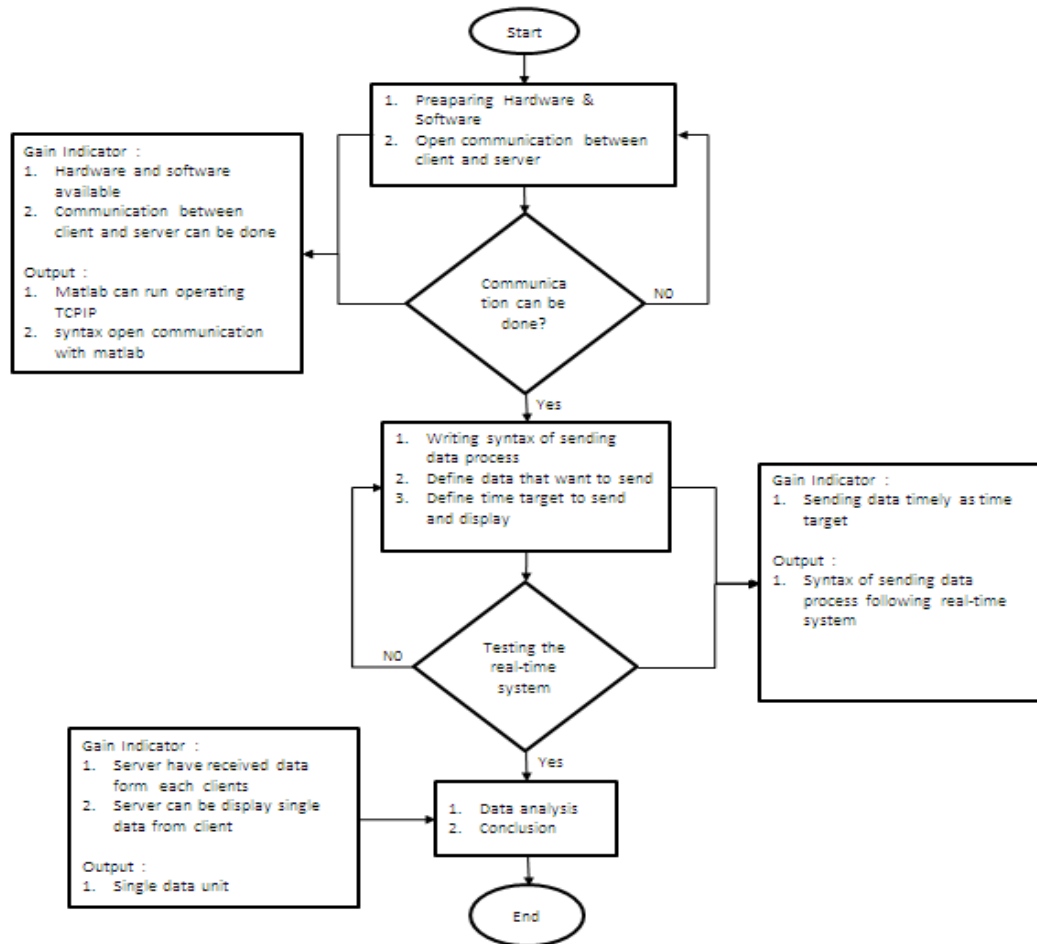
Figure 3: Flowchart of research

First step, we had to prepare hardware, software and communication system between client and server. Hardware that we used commonly laptop, there are 4 laptop, 3 for clients and another for server. Software, we used MATLAB, because easy for user and MATLAB have provided communication client-server with using TCPIP in MATLAB. Gain indicator for first step is hardware and software available and then communication between client and server must be connected. The out put was MATLAB could run TCPIP program and got syntax open communication with MATLAB.

Second step, was about to sending process from clients to server. Sending data used MATLAB, we must write the syntax correctly.

```
1       %===============
2       %CLIENT PROGRAM%
3       %===============
4  —    data = imread('D:\S2\RTS\fruitbat1.jpeg');
5  —    time_target = [2015 04 18 17 50];
6  —    s = whos('data');
7  —    s.size;
8  —    s.bytes;
9
10 —    tcpipclient = tcpip('192.168.9.155',5600,'NetworkRole','Client')
11 —    set(tcpipclient,'OutputBufferSize', s.bytes)
12
13
14 —  ☐ for i = 1 : 100000000
15 —        time_now = clock
16 —        if time_now(1:5) == time_target(1:5)
17
18 —            fopen(tcpipclient)
19 —            fwrite(tcpipclient,data(:),'uint8');
20 —            fclose(tcpipclient)
21 —            display('Send');
22 —            delay = 10;
23 —            break
24 —        end
25 —    └ end
26
```

Figure 4: Sending process program in client

Figure 4 is syntax client in there include data that want to send, time target, and communication process. The data that will be sent, we must know where is location the data exist and then define time target [2015 04 18 17 50]. It's mean [year month date hour minute]. Before that, we have to know size and byte every data.

```
1  —    data = imread('D:\S2\RTS\Gambar\fruitbat1.jpeg');
2
3  —    s = whos('data')
4  —    s.size
5  —    s.bytes
6
```

```
Command Window
ⓘ New to MATLAB? Watch this Video, see Examples, or read Getting Started.
            complex: 0
            nesting: [1x1 struct]
         persistent: 0


   ans =

      379     189      3


   ans =

         214893
```

Figure 5: Information data Program

Figure 5 is syntax to know size and byte the data that will be sent, that information will be used by server for preparing data place. After we knew size and byte, put it in syntax server, 214893 is size for input buffer while 379 189 3 is bytes for reshape data. Figure 6 was data and times target each client. Syntax's client and server were deferent because client will send the data so client must be active and server will receive the data so passive.

| Client's data 1 at 17:50 | Client's data 2 at 17:55 | Client's data 3 at 18:00 |

Figure 6: Data and time target each client


```matlab
%===============
%SERVER PROGRAM%
%===============
clear all
close all
clc


tcpipserver = tcpip('0.0.0.0',5500,'NetworkRole','Server')
set(tcpipserver,'InputBclearufferSize', 214893);

fopen(tcpipserver)

rawData = fread(tcpipserver, 214893, 'uint8');

fclose(tcpipserver)

reshapedData =  uint8(reshape(rawData,379,189,3));
imwrite(reshapedData,'D:\img\fruitbat1.jpeg');
```

Figure 7: Receiving data program in server

Figure 7 was server syntax, there were not time target because server just received but server must write the location where data must be put. Server program must be run first to open communication even client program, when time same with time target, program sending data will be run. First, open communication, send the data, close communication and then display send. The gain indicator for this step is process sending data with on time as time target and the output was syntax of sending data process in MATLAB.

Last step was result of data that received by server. Server received deferent data from three clients. In the last, server must combine all data to become one single data. For combining all data, we used Stitching Three Images using Correlation from Paresh Kamble in Maltab Central. We modified the syntax little bit for showing real image that sent to server from client.

```
1       %================
2       %SERVER PROGRAM%
3       %================
4       clc;
5       clear all;
6
7       time_target = [2015 4 18 18 05 00];
8
9       run('MidExRTS_Server2')
0
1    ⊟ for i = 1 : inf
2           time_now = clock ;
3           if time_now(1:5) == time_target(1:5)
4                 run('three_img_stitch')
5                 break
6           end
7    └ end
8
9         |
```

Figure 8: Display all data program in server

Figure.8 was syntax to show final result data that server received on time. For this syntax having time target because server will show off the all data that as time we have set. Time target that we defined at 18:05 because of last received at 18:00. The gain indicator for last step was server received all data from each client and then server can be display single data with on time as time target even output that were gotten was single data unit.

5. Result and Discussion

When all clients already send the data as time target and then the server will be display single one data became final result. The final result data of real-time system program was shown in figure 9.
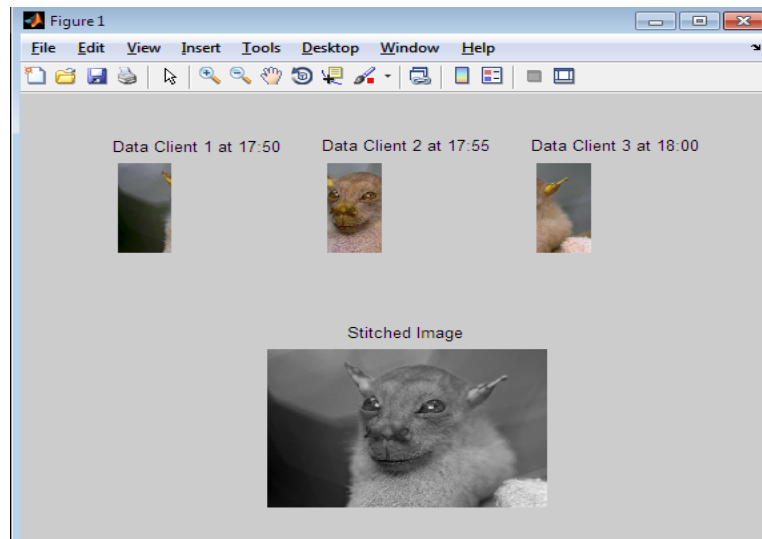
Figure 9: Final data

Data that sent to server not change but result final data have change to become gray in color side but image not change. Changing color with data because syntax from "Stitching Three Images using Correlation" not cause from sending process data. When we were running the system, we did not need to monitor all the time because we have designed the system automatically to send so we could be another activity. Then because we already set server display all data at 18:05, when we were checking in server computer around at 18:07, the server have displayed the all data. For all, sending process data from three clients to server with real-time system has been a success.

40

6. Conclusion and next research

1. For sending data from three clients to server with real-time system can be conduct.
2. With real-time system, the system more efficient because client can send the data on time as time target
3. With real-time system, the system more effective because we do not operator to running the system
4. For next research, send the data with bigger size and byte not only an image maybe image have 3 dimension

Acknowledgements

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Server Consolidation Toward Green IT

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Abstract

Based on the global needs of ecological friendly technology, makes Information Technology promote a new field called Green IT. Trough literature review, this paper is to propose a framework for green IT from the perspective of server consolidation. Hopefully this paper would be the initial framework to realize Green IT in companies or any other agencies.

1. Introduction

With the growing needs of Green IT movement implemented for corporate users IT department is finding the way to make their current infrastructure uses less power, less electricity, and less air conditioner that will reduce the cost of IT operation and makes the datacenter a lot more "green".

The resources that is used by the IT Operation is aligned with the CO2 emission that drive climate change to support faster data processing and increased storage capacity. The implementation of Green IT is to enhanced Energy Efficiency, that decreased IT related CO2 emission [8] and also power consumption that leads to heat emission of the datacenter.

To achieve Green IT in the datacenter one of the way to make is happened is by consolidating existing physical server environment to the virtual environment. Because in average servers are running around 10% from the total server capacity that uses the electricity, space, and cooling as if it runs on full capacity [1]. By converting the physical environment to the virtualized environment, will reduce multiple server workload to some physical servers. That will reduce the amount of physical servers, power consumptions, and air conditioner consumptions.

IT system resource optimization is needed to increase company competitiveness by optimizing the investment spend by the company to support operational cost. It is important to keep Green IT measurement align with the Business objective of the company. To contribute the research concerning Green IT alignment with Business Objectives, these research questions is arise:

- How to align Green IT with Company Business Objective to increase Company Competitiveness?
- What are the steps to achieve a Green Datacenter?

With this research paper, hopefully the journey to achieve Green IT is becoming easier and more measureable, and giving new insights concerning the strategic approach to achieve the potential of Green IT to enhance a value creation for Company Competitiveness.

2. Literature Review

Jason Harris studied 2 ways to reduce Company Operational Expanse, which is virtualization a technology that helps company to save hardware costs by creating multiple server instance in a single hardware and the Distributed Power Management is the way to disable or paused some un-accessed Virtual Machine so that the Physical server could be turned off. That saves power consumption and BIOS battery life.[9][10]

San Murugesan proposed a Green IT methodology that consists of Green use of IT System means that reducing energy consumption of servers and desktop PC, Green Manufacturing of IT System means that the manufacture hardware components or any other supporting devices has low or minimal environmental impact, Green Design of IT System means that the infrastructure design should use efficient electricity, cooling, sound and heat consumption, Green Disposal of IT System means that or re-use old hardware or refurbish the hardware in a friendly environmental manner.[11]

COBIT framework is used to monitor the transformation from common data center to a Green Datacenter. Because using COBIT framework has a governance layer that makes IT runs more efficiently and effectively. And COBIT uses the Balance Scorecard to translate high-level enterprise into manageable, specific IT-related goals and then map these to specific processes and practices. [2]

3. Server Consolidation based on COBIT Framework

Server Consolidation is the way of moving a workload from a physical server to a virtual server. Because in average servers are running around 10% from the total server capacity that uses the electricity, space, and cooling as if it runs on full capacity [1]. For example a single server could run multiple servers in a single physical server. That makes the cooling and electricity some physical server will become one physical server.

3.1. Physical to Virtual Migration

To migrate the physical server to a virtual server, some aspects should be considered such as the disk size, the used memory size, the processor utilization size, network throughput and disk IOPS. To achieve this a sizing tools is needed to measure the amount of load and then how many new physical server needed to run the migrated virtual environment to not only achieve the consolidated ratio, but also High Availability and Redundancy.

First the user would have to do the capacity planning phase; this phase is done to collect the server utilization for memory, processor, disks and network. So that at the end of the project the consolidation and redundancy aspects will be covered.
Second after the data is collected and the new hardware infrastructure is purchased, the next step is to do the physical to virtual migration using the migration tools. This step consume a lot of time and resources, because this step would involve the Management, Application team, Data base team, Infrastructure, Network and security, and the user that uses the application that is migrated to the virtual environment.
Third after the migration phase is done, the next step is to monitor the used of the capacity and the work load of the Virtual Machine so that the capacity is enough.

To monitor this activity, a framework is needed so that the whole activity will runs as good as it can be. COBIT 5 is one of the frameworks that can be used to monitor this activity.

3.2. COBIT 5

3.2.1. COBIT 5 Framework

COBIT 5 provides a comprehensive framework that assists enterprises in achieving their objectives for the governance and management of enterprise IT. Simply stated, it helps enterprises create optimal value from IT by maintaining a balance between realizing benefits and optimizing risk levels and resource use. COBIT 5 enables IT to be governed and managed in a holistic manner for the entire enterprise, taking in the full end-to-end business and IT functional areas of responsibility, considering

the IT-related interests of internal and external stakeholders. COBIT 5 is generic and useful for enterprises of all sizes, whether commercial, not-for-profit or in the public sector [3].

COBIT has five principles

1. Meeting Stakeholder Needs.
    Different Company has different needs and goals. COBIT translate high level enterprise goal to a specific manageable IT Goal.
2. Covering the Enterprise End to End.
    *   COBIT treats information and related technologies as assets and manage it like any other assets in the company
    *   COBIT considers all IT-related governance and management enablers to every aspects and end-to-end
3. Applying a single, integrated Framework.
    There are a lot of standards and best practice in IT, what COBIT do is align those standards at the high level and make it as the framework for governance and management of enterprise IT.
4. Enabling a Holistic Approach.
    For efficient and effective governance and management, COBIT defines a set of enablers to support the implementation of a comprehensive governance and management system.
    The enablers are:
    *   Principles, Policies and Frameworks
    *   Processes
    *   Organizational Structures
    *   Culture, Ethics and Behavior
    *   Information
    *   Services, Infrastructure and Applications
    *   People, Skills and Competencies

5. Separating Governance from Management.
    COBIT 5 makes a clear separation between Governance and Management.
    *   Governance
        Governance ensures that stakeholder needs, conditions and options are evaluated to determine balanced, agreed-on enterprise objectives to be achieved; setting direction through prioritization and decision making; and monitoring performance and compliance against agreed-on direction and objectives.

- Management

  Management plans, builds, runs and monitors activities in alignment with the direction set by the governance body to achieve the enterprise objectives.
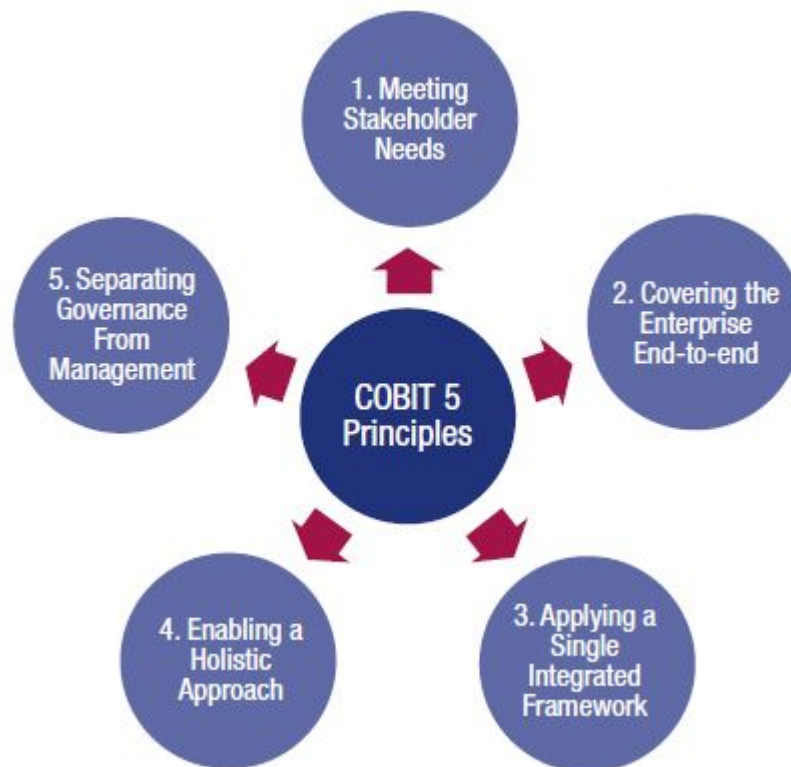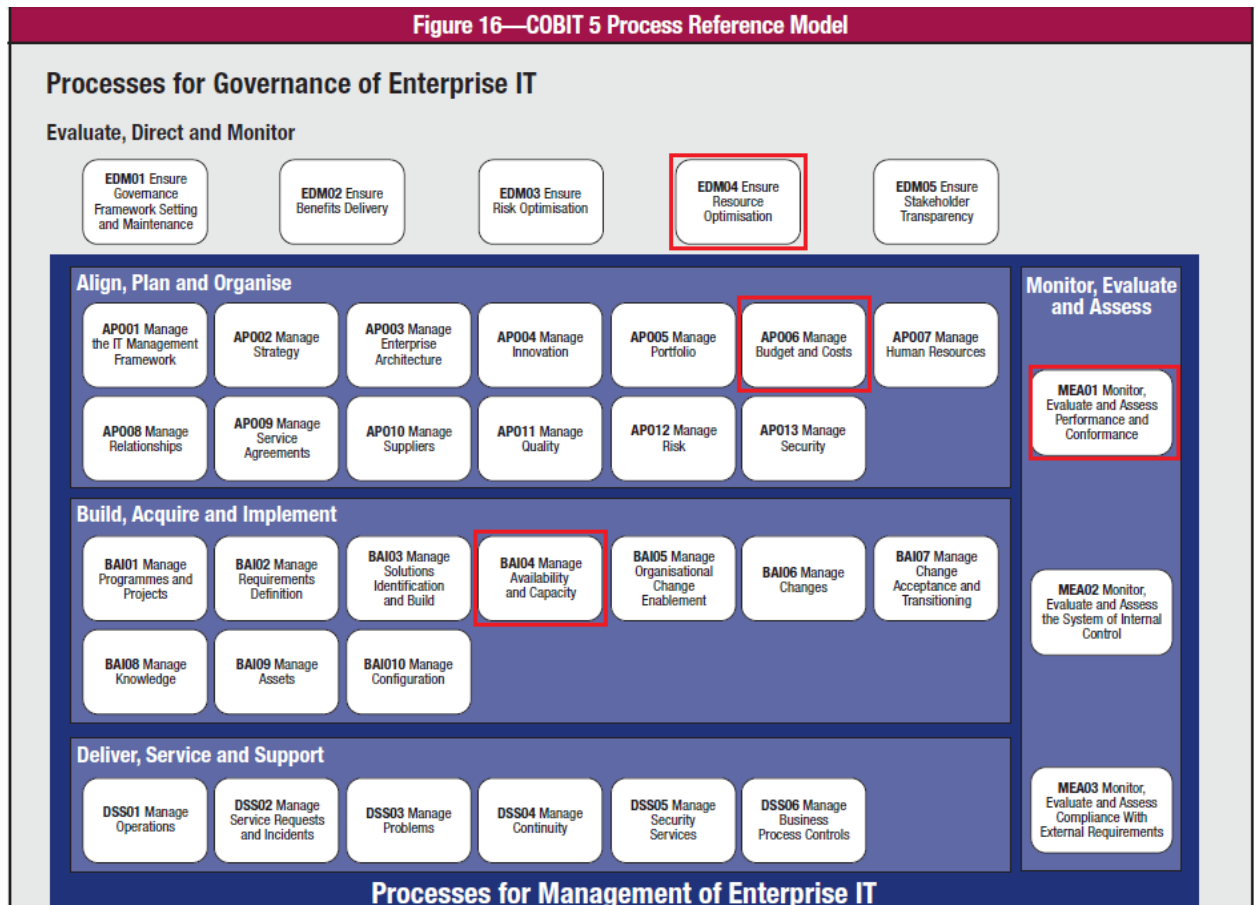

Figure 1 COBIT Framework

3.2.2. COBIT 5 Process

COBIT consists of 5 process for governance for ENTERPRISE IT. The process divided to 5 different domains. The domains are:

- Evaluate, Direct, and Monitor (EDM)
- Align, Plan, and Organize (APO)
- Build, Acquire, and Implement (BAI)
- Deliver, Service, and Support (DSS)
- Monitor, Evaluate, and Assess (MEA)

Picture 2. COBIT 5 Process

To determine the COBIT process used for server consolidation, it is important to highlight the most important process that involved if the servers are consolidated. From literature review and customer's interview, the selected process are :

- Evaluate, Direct and Monitor (**EDM04** Ensure Resource Optimisation)
- Align, Plan and Organize (**APO06** Manage Budget and Costs)
- Built, Acquire and Implement (**BAI04** Manage Availability and Capacity)
- Monitor, Evaluate and Asess (**MEA01** Monitor, Evaluate and Assess Performance and Conformance)

Based on COBIT 5 Enabling Documentation, the detailed process is as followed:

EDM04 Ensure Resource Optimisation
This process is needed ensure that IT has sufficient resources to stay aligned with business needs, by ensuring the Resource optimized will achieve these IT Related Goal

Table 1 EDM04 IT Related Goal

IT Related Goal	Expected Results
09 IT agility	• Because IT is agile makes Enterprise could adopt new system and application on their infrastructure • Will increase user satisfaction from business executive and users for their new application requirements
11 Optimization of IT assets, resources and capabilities	• Will saved cost for new hardware requirement if Enterprise would like to implement new Application • Will optimized used server resources
16 Competent and motivated business and IT personnel	• IT personnel skill will be updated due to training and enhancement for the new implemented system

Table 2 EDM04 RACI Chart

EDM04 RACI Chart Key Governance Practice	Board	Chief Executive Officer	Chief Financial Officer	Chief Operating Officer	Business Executives	Business Process Owners	Strategy Executive Committee	Steering (Programmes/Projects) Committee	Project Management Office	Value Management Office	Chief Risk Officer	Chief Information Security Officer	Architecture Board	Enterprise Risk Committee	Head Human Resources	Compliance	Audit	Chief Information Officer	Head Architect	Head Development	Head IT Operations	Head IT Administration	Service Manager	Information Security Manager	Business Continuity Manager	Privacy Officer
EDM04.01 Evaluate resource management.	A	R	C	C	R		R			I	C	C	C	C	C	C	C	R	C	C	C					
EDM04.03 Monitor resource management.	A	R	C	C	R	I	R	I	I	I	C	C	C	C	C	C	C	R	C	C	C	I	I	I	I	I

BAI04 Manage Availability and Capacity

Table 3 BAI04 IT Related Goal

IT Related Goal	Expected Results
07 Delivery of IT services in line with business requirements	• IT will have the ability to provide more application to support business needs by install it in a Virtual Machine
11 Optimization of IT assets, resources and capabilities	• Physical server usually only used 10% of its capacity. By using Virtualization multiple load could run in a single Physical Server
14 Availability of reliable and useful information for decision making	• By using Virtualization company will gets hardware redundancy features from the High Availability Clustering.

Table 4 BAI04 RACI Chart

BAI04 RACI Chart	Board	Chief Executive Officer	Chief Financial Officer	Chief Operating Officer	Business Executives	Business Process Owners	Strategy Executive Committee	Steering (Programmes/Projects) Committee	Project Management Office	Value Management Office	Chief Risk Officer	Chief Information Security Officer	Architecture Board	Enterprise Risk Committee	Head Human Resources	Compliance	Audit	Chief Information Officer	Head Architect	Head Development	Head IT Operations	Head IT Administration	Service Manager	Information Security Manager	Business Continuity Manager	Privacy Officer
BAI04.01 Assess current availability, performance and capacity and create a baseline.						I												C		C	A		R	C	C	
BAI04.02 Assess business impact.						A												C		C	R		R	C	C	
BAI04.03 Plan for new or changed service requirements.						R												C		C	A		R	C	C	
BAI04.04 Monitor and review availability and capacity.						R												C		C	A		R	C	C	
BAI04.05 Investigate and address availability, performance and capacity issues.					I	R												I	R	C	A		R	I	I	

MEA01 Monitor, Evaluate and Assess Performance and Conformance

Table 5 MEA01 IT Related Goal

IT Related Goal	Expected Results
04 Managed IT-related business risk	• IT related operations and implementation activity will have the risks covered by the risk assessor
07 Delivery of IT services in line with business requirements	• Customer will be satisfied by IT Service Delivery
11 Optimization of IT assets, resources and capabilities	• IT resources assets will be optimized, and IT operation costs will be reduced
15 IT compliance with internal policies	• All IT related activity will be comply with internal auditor policies

Table 6 MEA01 RACI Chart

MEA01 RACI Chart

Key Management Practice	Board	Chief Executive Officer	Chief Financial Officer	Chief Operating Officer	Business Executives	Business Process Owners	Strategy Executive Committee	Steering (Programmes/Projects) Committee	Project Management Office	Value Management Office	Chief Risk Officer	Chief Information Security Officer	Architecture Board	Enterprise Risk Committee	Head Human Resources	Compliance	Audit	Chief Information Officer	Head Architect	Head Development	Head IT Operations	Head IT Administration	Service Manager	Information Security Manager	Business Continuity Manager	Privacy Officer
MEA01.01 Establish a monitoring approach.		A	R	R	R	I	C		I						C	C	C	R	I	C	C	I	C	I	I	I
MEA01.02 Set performance and conformance targets.		I	I	I	A	R			I						C			C	C	R	R	I	R	I	I	I
MEA01.03 Collect and process performance and conformance data.					C	R			I						C			A		R	R	I	R	I	I	I
MEA01.04 Analyse and report performance.					A	R			C						C	C	C	C	C	R	R	C	R	C	C	C
MEA01.05 Ensure the implementation of corrective actions.	I	I	I	I	C	R			C						C	C	C	A	C	R	R	C	R	C	C	C

APO06 Manage Budget and Costs

Manage IT related expanses is very important to ensure Enterprise goals is achieved efficiently and would not have huge impact on the Enterprise financial condition.

Table 7 APO06 IT Related Goal

IT Related Goal	Expected Results
05 Realised benefits from IT-enabled investments and services portfolio	• There will be budget comparison before the virtualization implementation and after implementation. • There will be Service Level Agreement comparison before the virtualization implementation and after implementation.
06 Transparency of IT costs, benefits and risk	• The use of IT budget should be transparent and comparable

Table 8 APO06 RACI Chart

APO06 RACI Chart

Key Management Practice	Board	Chief Executive Officer	Chief Financial Officer	Chief Operating Officer	Business Executives	Business Process Owners	Strategy Executive Committee	Steering (Programmes/Projects) Committee	Project Management Office	Value Management Office	Chief Risk Officer	Chief Information Security Officer	Architecture Board	Enterprise Risk Committee	Head Human Resources	Compliance	Audit	Chief Information Officer	Head Architect	Head Development	Head IT Operations	Head IT Administration	Service Manager	Information Security Manager	Business Continuity Manager	Privacy Officer
APO06.02 Prioritise resource allocation.	I	R		C	C	C	I	C	C		I							A	I	C	C	R	C	C		
APO06.03 Create and maintain budgets.	I		A	C	C	C	C	C	C									R	C	C	C	R	C	C	C	

3.2.3. Physical Server Consolidation

After all process interview, and formulation is done, the next step is to consolidate the servers. Based on the physical asessment result and interview with the Accountable and Responsible person in **BAI04** process. The example result is as followed.

Table 9 Example list of Existing server

No	Device Name	Model / Jenis	Processor (GHz)	Memmory (GHz)	Hard Disk (GB)	Rack	Operation System	Power Consumption (W)
1	Server Proliant	DL360 G5	1	2	110	R1	Redhat Linux 5	700
2	Server Proliant	DL360 G4	1	2	250	R1	W2K3	700
3	Blade Enclosure	Enclosure C7000				R1	-	900
4	Server Proliant	BL460 G6	2	16	120	R1	W2K8 64 bit	
5	Server Proliant	BL460 G6	2	16	120	R1	W2K8 64 bit	
6	Server Proliant	BL460 G6	2	16	120	R1	W2K8 64 bit	
7	Server Proliant	BL460 G6	2	16	120	R1	W2K8 64 bit	
8	Server Proliant	DL360 G5	1	1	50	R2	W2K	700
9	Server Proliant	DL380 G4	1	2	200	R2	W2K3 R2	700
10	Server Proliant	DL360 G4	1	2	50	R2	W2K3	700
11	Server Proliant	ML350G3	1	2	50	R2	W2K3	700
12	Server Proliant	ML370G5	2	2	300	R2	W2k3	700
13	System X server	X3650	2	1	80	R3	W2k3	750
14	System X server	X3650	2	1	80	R3	W2k3	750
15	System X server	X3550	2	1	80	R3	W2k3	750
16	External Storage				1000	R1		855

From the table above we could roughly take data that the power that is needed for the infrastructure is 8050 Watts

After the servers are consolidated, the expected result is as followed.

Table 10 Example After Migration

No	Device Name	Model / Jenis	Processor (GHz)	Memmory (GHz)	Hard Disk (GB)	Rack	Operation System	Power Consumption (W)
1	Blade Enclosure	Enclosure C7000				R1	-	900
2	Server Proliant	BL460 G6	2	16	120	R1	W2K8 64 bit	
3	Server Proliant	BL460 G6	2	16	120	R1	W2K8 64 bit	
4	Server Proliant	BL460 G6	2	16	120	R1	W2K8 64 bit	
5	Server Proliant	BL460 G6	2	16	120	R1	W2K8 64 bit	
6	Server Proliant	BL460 G6	2	64	120	R1	ESXi	
7	Server Proliant	BL460 G6	2	64	120	R1	ESXi	
8	External Storage				3000	R1		855

From the table above, the power consumption used is 1755 Watts. A very significant result showed in power consumption

4. Benefits and Concerns

There are some factors that are considered as Benefits and Concerns when a company is using Virtualized environment.

4.1. Benefits

These are the benefit of Virtualized Environment [6]
- Company would not pay for the hardware purchased to cover for business requirement for a certain time usually three to five years, depends on the hardware capacity.
- Company will get hardware redundancy by using the Cluster Features from the Virtualization vendors.
- Reduce the data center footprint by reducing the amount of used power, cooling, and racks.
- Have a testing environment that is not mixed with production environment.
- Faster server provisioning when deploying new Virtual Machine from a standardized Templates.
- Isolate applications, in the physical world one server could only contain one application, now multiple applications could run in one physical server using different Virtual Machines.

4.2. Concerns

There are some concerns if a company would like to implement Virtualized Environment [7]:
- Misconfiguring virtual hosting platforms, guests, and networks.
- Failure to properly separate duties and deploy least privilege controls.
- Failure to integrate into change/lifecycle management.
- Lack VM visibility across the enterprise

5. Conclusion & Futureworks

By using Virtualized Environment, a company could reduce the amount of electricity used to run the datacenter, more agile environment to support Business Needs, reduced cost of hardware purchased. In the future the green IT movement needs to be socialized

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Assessment COBIT 5 Support Time Efficiency in IT Services at PT. XYZ

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Abstract

COBIT (Control Objectives for Information and related Technology) developed by ISACA (Information Systems and Control Association) and ITGI (Information Technology Governance Institute) in 1992 and then used as a model of IT governance started from planning to evaluation. COBIT will always be synchronized with the standards, best practice and guidance within an organization / company.

COBIT is an IT governance framework good practice applicable International which is useful for understanding how a Manager managing and bridging the gap within an organization / company between requirements, technical issues, business risks that may arise and control to be delivered to the stakeholders. COBIT 5 is divided into 5 domains and the 37 IT process, they are:

1. Evaluate, Direct and Monitor (EDM). ➔ 5 IT process.
2. Align, Plan and Organize (APO). ➔ 13 IT process.
3. Build, Acquire and Implement (BAI). ➔10 IT process
4. Deliver, Service and Support (DSS). ➔ 6 IT process
5. Monitor, Evaluate and Assess (MEA). ➔ 3 IT process

In the discussion of this paper author will discuss about Assessment COBIT 5 to support time efficiency in IT services at PT.XYZ in area domain Align, Plan and Organize (APO) especially in "Manage business agreements – APO09" at the company where the author works.

1. Introduction

PT. XYZ is a company that has a service area in energy side and they produce oil & gas in west java. The gas transmission is using EJGP (East Java Gas Pipeline) pipeline to deliver in each buyer at east java.

With the implementation of COBIT 5 is expected to provide input and make a good practice that applies to support the business strategy of the company, among others by improve IT services to internal users, improve IT controls and benchmarks in the Company.

Information Technology requires an investment that is not cheap therefore need a proper understanding of the basic concepts technology used, the operating system, applications and security applied to protect information in the management and development of IT systems in the enterprise. In addition to things mentioned above we also have to focus on improving the quality of business strategy to support the enterprise related with IT.

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It is expected that by implementing COBIT 5 in PT.XYZ when viewed in PPT (People, Process, Technology) all the people involved in IT can use good practice IT framework that have been made so hopefully can increase in value-added IT-effective, efficient, innovative and effective also reduce business risk can be identified and synergy with the business strategy of the company.

2. Literature Review

The purpose of writing this paper is to understand concept, find out and comparative implementation of COBIT 5 as a good practice in PT.XYZ where author works. The problem found after understanding the COBIT then mapping where the author works that have not define value of Service Deliverable Agreement (SDA) to the user.

Definition of Service Deliverable Agreement is how long IT helpdesk doing assistance & issue at user. Expected when the value of the SDA has determined it will be measurable in the efficient and effective performance of an IT helpdesk. *(Shown in figure 1)*.

3. Methodology.

Methodology used in this paper is a quantitative and qualitative method and literature based on the concept guidelines framework COBIT 5.

4. Discussion.

The discussion in this paper is about area domain Align, Plan and Organize (APO) - 09 Manage service agreements *(shown in figure 2)*. If the COBIT process mapping with IT related goals then obtained as follows:
1. Delivery of IT services in line with business requirements.
2. Availability of reliable and useful information for decision making *(shown in figure 3)*.

In everyday to support activities in the office and in the field, IT helpdesk team will help users troubleshoot in case mild to moderate related to the IT area in terms of hardware, software and applications.

Therefore, when before users begin to activities IT helpdesk on duty had to be first to arrive at the office to ensure all Servers, links, networks and applications running smoothly and can be used with well. Also to support the activities in the next day IT helpdesk on duty back to check on the evening before the left to ensure all systems are in good health and no malfunction so tomorrow morning ready to be operationalized.

In research and assessment that I know related with COBIT 5, the case is Service Deliverable Agreement does not exist, so an IT helpdesk in conducting the activities in users can not be properly monitored. For example a real case, when an IT helpdesk do the job of moving users only 2 people, the time worked by an IT helpdesk to moving the spent +/- 5 hours 44 minutes (from jam 16.00 wib – until 21.44 wib) is quite a very long time to relocation only 2 users. The job in relocation is simply move the PC from one place to the place and within a short distance of only +/- 3-4 meter. Which is in the normal condition the work could only take about 30 minutes for two users. *(Shown in figure 4)*.

From there looks IT helpdesk not yet effective and efficient in the performance to support the user's daily activities especially when having to synergy with the vision and mission of the company in supporting business strategy. Effective means IT helpdesk have to doing the job exactly, good and right while the efficiency is more to the time spent to support work that will impacted on the amount of overtime to be paid to the IT helpdesk.

Increasing the role of IT in a company is needed with the expectation that can support business Strategy Company. Other than that IT should also be able to provide services to their users such as services to the finance department, exploration, marketing etc. Function and IT role should be managed and organized well and should have a good practice which is the benchmark of providing the service to the user. If IT managed and organized well it will bring a positive impact to the company. To maintain and measure the system availability where the author works, already implemented SLA (Service Level Agreement) with a value of 99.84% for the system reliability. SLA measurement is 24 hours x 365 days=8760hours, 99.84% x 8760 hours = 8746 hours, the difference between 8760 hours to 8746 hours is 14 Hours. It means that in a year in order to comply with a predefined SLA the system maximum

downtime allowed is only 14 hours. To measure that performance availability system already implemented software to monitor each server with third party software *(shown in figure 5)*.

The same with SLA for SDA (Service Deliverable Agreement) define to measure how long system support handles problem solving, issue and assistance. Hopefully with have a value of SDA IT more excellent deliver services to users *(shown in figure 6)*

How do well manage, of course need a supporting could from personnel's, technical and non technical. In the personnel side to manage well is always updated with the current IT technology. In technical side is implementation of a new technology that supports the business strategy company. Non technical side is conducting with monitoring the services as well as creating service level promised to user and management.

Company business requirements are cost efficiency and effective, how IT can catch up and support those requirements. Cost efficiency and effective is a standard for all companies because with minimum requirements can get maximum income. A way to cost efficiency and effective in IT is with tender mechanism for purchasing.

IT is expected to contribute as much as possible for the company when management decisions require a fast and precise, it can be immediately served. The place where the author works it has been implemented, among others, the applications name is on-line gas monitoring *(shown in figure 7)*. In the application software management can quickly make a decision related to the sales of gas to the buyer. The use of the application software will be known to the amount of gas flowing to each buyer and will also be monitored if the amount of gas delivered to the buyer looks lower than the agreed nomination. An application used by the IT is also monitored, so if applications are down it will be any notification to the admin of the application owner.

If remapping between the IT-related goals with enterprise goals *(shown in figure 8)*, then there are things that should be a major concern with the category of Primary (P), namely:
1. Stakeholder value of business investments.
2. Portfolio of competitive products and services.
3. Customer-oriented service culture
4. Agile responses to a changing business environment
5. Optimization of service delivery costs
6. Business service continuity and availability
7. Information-based strategic decision making

Discussion about value of business investment and portfolio, IT can provide information with accurate, precise and reliable in terms of data source for potential reservoir oil and gas. After doing the analysis data can be used for next step. The data analyzed by software application. In the application will be seen how big oil and gas reserves as well as the depth of how many meters. Drilling did without accurate data study measurement definitely very expensive. Because don't know exactly where is the reservoir location and how depth the content of oil & gas. Measurement is also a factor in reducing the risk, whether the risk of failure and risk of loss of the drilling company.

In generally IT provide services to users in each company, other ways in IT where author works. Customer oriented in author works implemented with system support /helpdesk as a person who will help users with problem solving, assistance and issue, available to with customer centre any time in office hour please call extension 4888. Every task helpdesk will save in helpdesk software application and monitored then could be measure. To support helpdesk we implemented too voice mailbox, this application will informed from who called the number of helpdesk call centre and sent to outlook email *(shown in figure 9)*.

Cost optimization implemented too in author works, every kind of bidding process will use tender mechanism. Whether it is open tender and or online tender system *(shown in figure 10)*. In tender process IT also makes software application to monitoring the process of tender so that clearly and transparency and any kind of process activities tender could be measure and accountable.

Currently where author works already implemented disaster recovery system mechanisms with cold backup categorize Tier-1and process to upgrade hot backup categorize Tier-3. With changes of Tier process hopefully if disaster happened all of office activities can run normally and smoothly. Because if disaster happened the data is very crucial even though the process of production oil and gas still running.

Strategic decision making based on IT implemented in reporting production. The reporting reported to stakeholder and shareholder. Production report reported to stakeholder every night given to regulator where author works for the next is information for lifting production oil & gas for the country.

Reporting is not only for production but also reporting for Asset of the country. Because these assets are owned by the State so that before the write-off the assets / goods are to be maintained and its existence should not be lost. Place where author works in Asset better known by the name of goods AFE (Authorization For Expenditure) which is a project monitoring tool and are uncertain which describes all of the components required to perform these activities include materials, labor, equipment and budget. AFE was created to provide information in order to do the analysis, the evaluation of which will be approved and monitored by the stakeholders. Project activities must be approved before being implemented AFE.

5. Conclusions

In this paper author present about assessment COBIT 5 to support time efficiency in IT services at PT. XYZ. In this explanation is still needed a lot of improvement since the scope of COBIT 5 is also much to be described in its application in the enterprise, and aware of the deficiencies in the writing of the presentation and explanation. Outputs from understanding this framework are performance reports & update IT operational portfolio so that each individual involved in IT can deliver optimal value in order to increase the effectiveness and to inefficiencies in order to better support the business strategy. With continuous improvement in the system of IT helpdesk achievement value of Service Deliverable Agreement shall be measurable, accountable and transparent so that it will increase in IT services to users. In order to achieve effective and efficiency it is expected that the IT helpdesk can carefully identifying and evaluating the issue & assistance in IT-related, so it could be optimally to serve the users and finally upgrade the performance and IT Operations to support activities of the enterprise in achieving the business goals of the strategy.

Figures:

Figure 1: Categorizing service deliverable
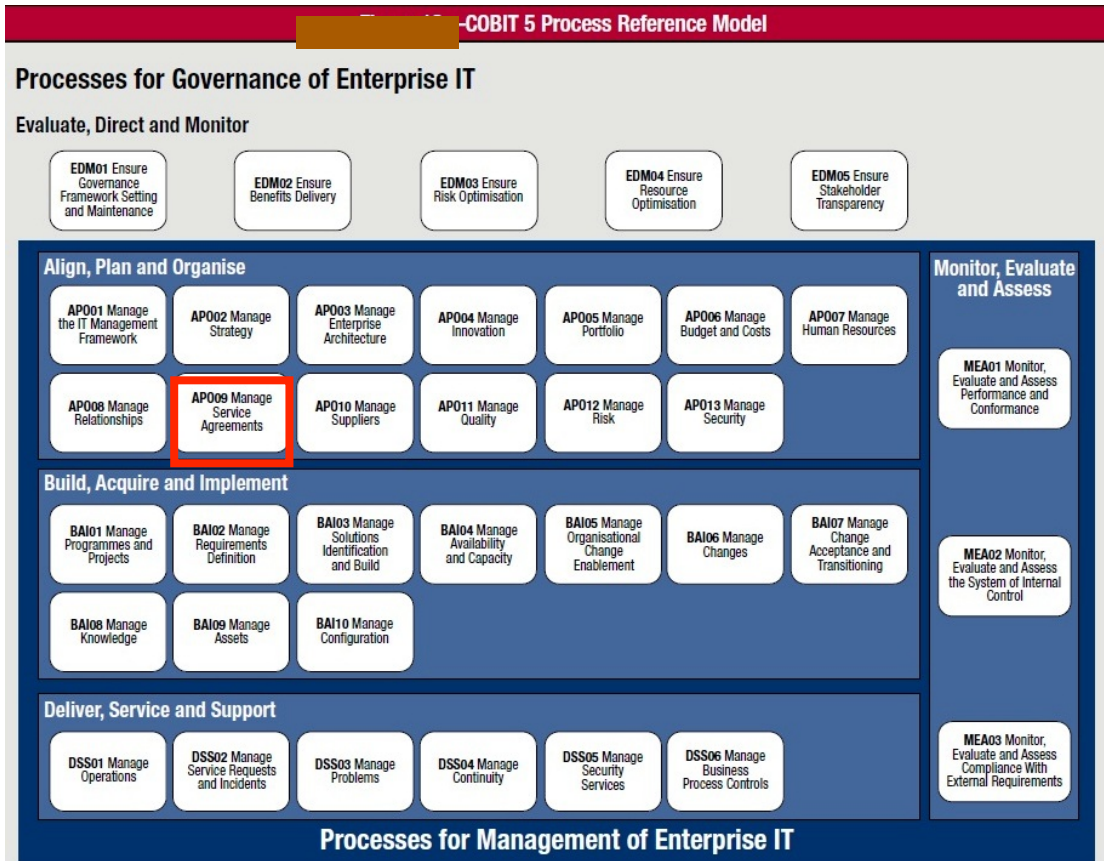
Figure 2: COBIT process

Mapping COBIT 5 IT-related Goals to Processes

| COBIT 5 Process		01 Alignment of IT and business strategy	02 IT compliance and support for business compliance with external laws and regulations	03 Commitment of executive management for making IT-related decisions	04 Managed IT-related business risk	05 Realised benefits from IT-enabled investments and services portfolio	06 Transparency of IT costs, benefits and risk	07 Delivery of IT services in line with business requirements	08 Adequate use of applications, information and technology solutions	09 IT agility	10 Security of information, processing infrastructure and applications	11 Optimisation of IT assets, resources and capabilities	12 Enablement and support of business processes by integrating applications and technology into business processes	13 Delivery of programmes delivering benefits, on time, on budget, and meeting requirements and quality standards	14 Availability of reliable and useful information for decision making	15 IT compliance with internal policies	16 Competent and motivated business and IT personnel	17 Knowledge, expertise and initiatives for business innovation
		Financial						**Customer**		**Internal**						**Learning and Growth**		
EDM01	Ensure Governance Framework Setting and Maintenance	P	S	P	S	S	S	P		S	S	S	S	S	S	S	S	S
EDM02	Ensure Benefits Delivery	P		S		P	P	P			S	S		S	S		S	P
EDM03	Ensure Risk Optimisation	S	S	S	P		P	S			P			S	S	P	S	S
EDM04	Ensure Resource Optimisation	S		S	S	S	S	S		P		P		S			P	S
EDM05	Ensure Stakeholder Transparency	S	S	P			P	P						S	S	S		S
APO01	Manage the IT Management Framework	P	P	S	S			S		P	S	P	S	S	S	P	P	P
APO02	Manage Strategy	P		S	S			P	S		S	S	S		S	S	S	P
APO03	Manage Enterprise Architecture	P		S	S	S	S	S		P	S	P	S		S			S
APO04	Manage Innovation	S			S	P			P	P	S	S		S				P
APO05	Manage Portfolio	P		S	S	P	S	S	S	S		S		P				S
APO06	Manage Budget and Costs	S		S	S	P	S	S			S		S					
APO07	Manage Human Resources	P	S	S	S			S		S	S	P		P		S	P	P
APO08	Manage Relationships	P		S	S	S	S	P	S		S	P				S	S	P
APO09	Manage Service Agreements	S			S	S	S	P	S	S	S		S	P	S			
APO10	Manage Suppliers		S		P	S		S	P	S	P	S		S	S	S		S
APO11	Manage Quality	S	S		S	P		S	S		S		P	S	S	S		
APO12	Manage Risk		P		P			S	S	S	P		P	S	S	S	S	
APO13	Manage Security		P		P			P	S	S		P			P			

Figure 3: Mapping COBIT process with IT related goal
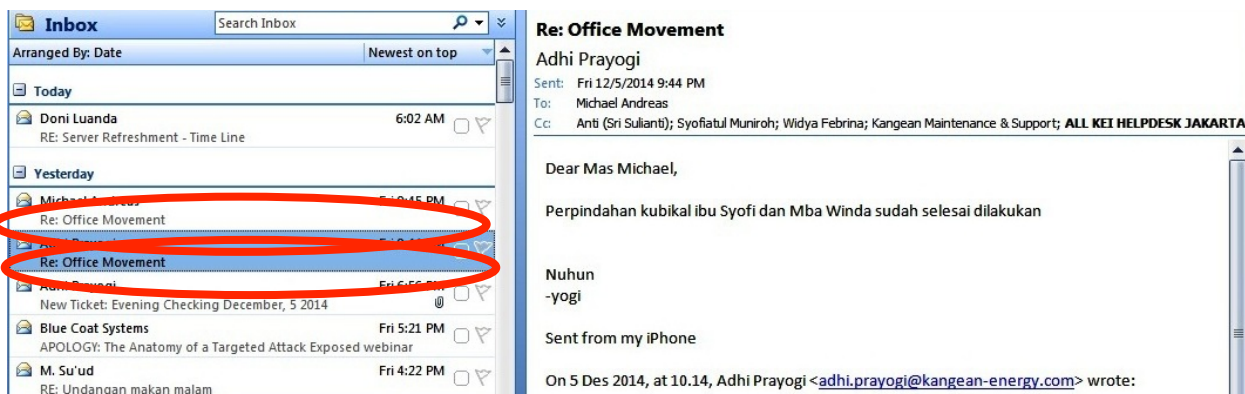
Figure 4: Working not Efficiency & not Effective

Figure 5: Third party software for monitoring tools

| No	SDA Promise to Management	97.8%					
1	**Telecom :**	Minutes	Hours	Difference	Working hours	Remark	Percentage SDA
	New handset	13	0.216	7.784	8	Hours	97.3%
	Fax	5	0.088	7.912	8	Hours	98.9%
	Radio HT	7	0.12	7.88	8	Hours	98.5%
	Base radio	13	0.216	7.784	8	Hours	97.3%
	Telephone movement	13	0.216	7.784	8	Hours	97.3%
	Others	13	0.216	7.784	8	Hours	97.3%
	Total						97.8%
2	**Dismantling:**						
	PC Desktop	3	0.056	7.944	8	Hours	99.3%
	Telephone	5	0.088	7.912	8	Hours	98.9%
	Others	13	0.216	7.784	8	Hours	97.3%
	Total						98.5%
3	**PC Software :**						
	Ms Visio	13	0.216	7.784	8	Hours	97.3%
	Autocad	13	0.216	7.784	8	Hours	97.3%
	Adobe Professional	13	0.216	7.784	8	Hours	97.3%
	Ms Project	13	0.216	7.784	8	Hours	97.3%
	Winrar	13	0.216	7.784	8	Hours	97.3%
	Others	13	0.216	7.784	8	Hours	97.3%
	Total						97.3%
4	**Applications:**						
	eDMS	5	0.088	7.912	8	Hours	98.9%
	Timesheet / HRIS	4	0.072	7.928	8	Hours	99.1%
	Oracle	7	0.12	7.88	8	Hours	98.5%

Figure 6: Service Deliverable Agreement (SDA)
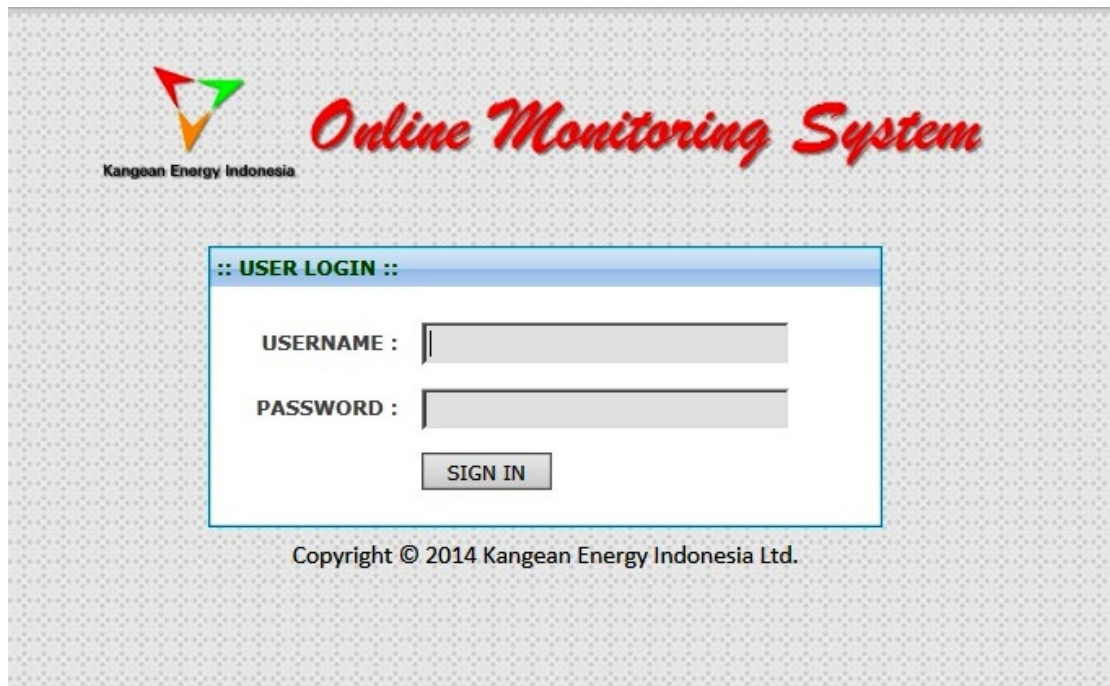
Figure 7: Application Online monitoring system

Figure 22—Mapping COBIT 5 Enterprise Goals to IT-related Goals

IT-related Goal		1. Stakeholder value of business investments	2. Portfolio of competitive products and services	3. Managed business risk (safeguarding of assets)	4. Compliance with external laws and regulations	5. Financial transparency	6. Customer-oriented service culture	7. Business service continuity and availability	8. Agile responses to a changing business environment	9. Information-based strategic decision making	10. Optimisation of service delivery costs	11. Optimisation of business process functionality	12. Optimisation of business process costs	13. Managed business change programmes	14. Operational and staff productivity	15. Compliance with internal policies	16. Skilled and motivated people	17. Product and business innovation culture
		Financial					Customer					Internal					Learning and Growth	
Financial	01 Alignment of IT and business strategy	P	P	S			P	S	P	P	S	P	S	P			S	S
	02 IT compliance and support for business compliance with external laws and regulations			S	P											P		
	03 Commitment of executive management for making IT-related decisions	P	S	S				S	S			S		P			S	S
	04 Managed IT-related business risk			P	S			P	S		P			S		S	S	
	05 Realised benefits from IT-enabled investments and services portfolio	P	P				S		S		S	S	P		S			S
	06 Transparency of IT costs, benefits and risk	S		S		P				S	P		P					
Customer	07 Delivery of IT services in line with business requirements	P	P	S	S		P	S	P	S		P	S	S			S	S
	08 Adequate use of applications, information and technology solutions	S	S	S			S	S		S	S	P	S		P		S	S
	09 IT agility	S	P	S			S		P			P		S	S		S	P
	10 Security of information, processing infrastructure and applications			P	P			P								P		
Internal	11 Optimisation of IT assets, resources and capabilities	P	S					S			P	S	P	S	S			S
	12 Enablement and support of business processes by integrating applications and technology into business processes	S	P	S			S		S		S	P	S	S	S			S
	13 Delivery of programmes delivering benefits, on time, on budget, and meeting requirements and quality standards	P	S	S			S				S		S	P				
	14 Availability of reliable and useful information for decision making	S	S	S	S			P		P	S							
	15 IT compliance with internal policies			S	S										P			
Learning and Growth	16 Competent and motivated business and IT personnel	S	S	P			S		S						P		P	S
	17 Knowledge, expertise and initiatives for business innovation	S	P				S		P	S		S		S			S	P

Figure 8: Mapping COBIT IT related goal with Enterprise goal

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Figure 9: Voice mailbox

Figure 10: Electronic Procurement

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Enhancing ERP to Fit the Business Needs: A Customization Method Selection

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Abstract

Enterprise resource planning and management (ERP) systems is now dominated by systems that are perceived expensive and inflexible. In order to take full advantage of the ERP systems, implementations require drastic structural and cultural changes within the organization including business process reengineering. These changes certainly allowed to do but somewhat difficult to accomplish and organizations continue to struggle with change management of ERP systems. Finding the right fit between ERP systems and the business processes is critical for successful ERP implementation [12]. In this case, the organization can respond by two approaches: ERP system customization or organizational adaptation [6][15]. However, there is also best of breed systems, which are best applied to one or a few functions, facilitating system maintenance. This research proposes a comprehensive ERP system customization selection framework in which the objective hierarchy is constructed and the appropriate criterias are specified to provide detailed guidance for the customization. The analytic hierarchy process (AHP) method [27] is applied for dealing with the ambiguities involved in the assessment of customization alternatives and relative importance weightings of criterias.

2. Introduction

Along with the raising of software technology, application makers are competing to produce integrated business management software, that organizations can use to collect, store, manage and interpret the data from many business activities into one enterprise system. This system is called Enterprise Resource Planning (ERP) which has become the dominant strategic platform for supporting enterprise-wide business processes nowadays. ERP is increasingly important in modern business because of its ability to integrate the flow of material, finance, and information and to support organizational strategies [43][42]. A successful ERP project involves managing business process change, selecting an ERP software system and a co-operative vendor, implementing this system, and examining the practicality of the new system. Because of the complexity of the business environment, the limitations in available resources, and the diversity of ERP alternatives, implementation of ERP system is tiring and time consuming. However, given the considerable financial investment and potential risks and benefits, the importance of a pertinent ERP system selection cannot be over emphasized [39].

The implementation of the system often does not fully meet the needs of the organization so frequent changes (customizations) and extensive maintenance are required [21]. Organizations can choose to have custom software built to meet their unique requirements but this imposes additional costs, risks, and implementation delays [5][10]. Existing ERP commercial packages cannot provide a once-for-all business model for every process of all industry. Thus, no single ERP packaged software can meet all organization functionalities or all special business requirements [31][39][12]. Therefore, companies must choose a flexible ERP system and a cooperative vendor that is responsive to customer needs. Achieving fit is a costly proposition. Efforts aimed at ongoing maintenance and enhancements cost approximately $1.5 million annually per ERP implementation [3]. Collectively, U.S.-based organizations are spending $14.5 billion annually on ERP maintenance and enhancements [37]. In a recent survey of U.S. CIOs, 47% cited ERP upgrades and enhancements as key investments for 2006 [14]. Achieving fit is not as easy as simply upgrading to new versions, implementing new modules, or customizing the existing system. It requires the synthesis of knowledge from throughout the

organization. Functional business knowledge must be brought to bear to identify deficiencies in current functionality and anticipated future strategic directions. ERP-technical knowledge must also be tapped to specify the system-level impacts of new functionality. In summary, achieving fit between the ERP as delivered and business needs is a complex organizational issue that is not easily solved. Finding the right fit between ERP systems and the business processes of the target organization is critical for successful ERP implementation [12]. In the case of a misfit between the ERP system and the organization's established practices, the organization can respond by two approaches: ERP system customization or organizational adaptation [6][15].

This research proposes a comprehensive ERP system customization selection framework in which the objective hierarchy is constructed and the appropriate criteria are specified to provide detailed guidance for the customization. Thus, the research is driven by this research questions: *Which is the best methods for ERP system customization to fit the business needs?*

The analytic hierarchy process (AHP) method [27] is applied for dealing with the ambiguities involved in the assessment of customization alternatives and relative importance weightings of criteria.

3. The Enterprise Resource Planning (ERP) System

Enterprise Resource Planning is a term used to describe business software that is 1) multifunctional in scope, 2) integrated in nature, and 3) modular in structure. An ERP software solution is appropriate when an organization is seeking the benefits of business process integration and contemporary best practices in its information system, looking for a full range of functionality throughout its organization, and seeking to limit its implementation and ongoing support costs [7]. ERP systems have their origins in Manufacturing Resource Planning (MRP) software with installations traditionally in large scale manufacturing facilities, although recently the trend is to extend installations to industry. The systems are known for their process orientation rather than traditional functional orientation that may enhance an organization's move toward breaking down departmental boundaries and thinking. The goal of implementing these packages is to reengineer their processes, which in turn will hopefully benefit their bottom line.

The ERP systems are meant to support enterprises in various phases of the business. The application software typically includes warehouse management, material management, production planning and management, people management, purchase management, customer relations management (CRM), and supply chain management (SCM). Figure 1 illustrates the ERP systems as a whole.
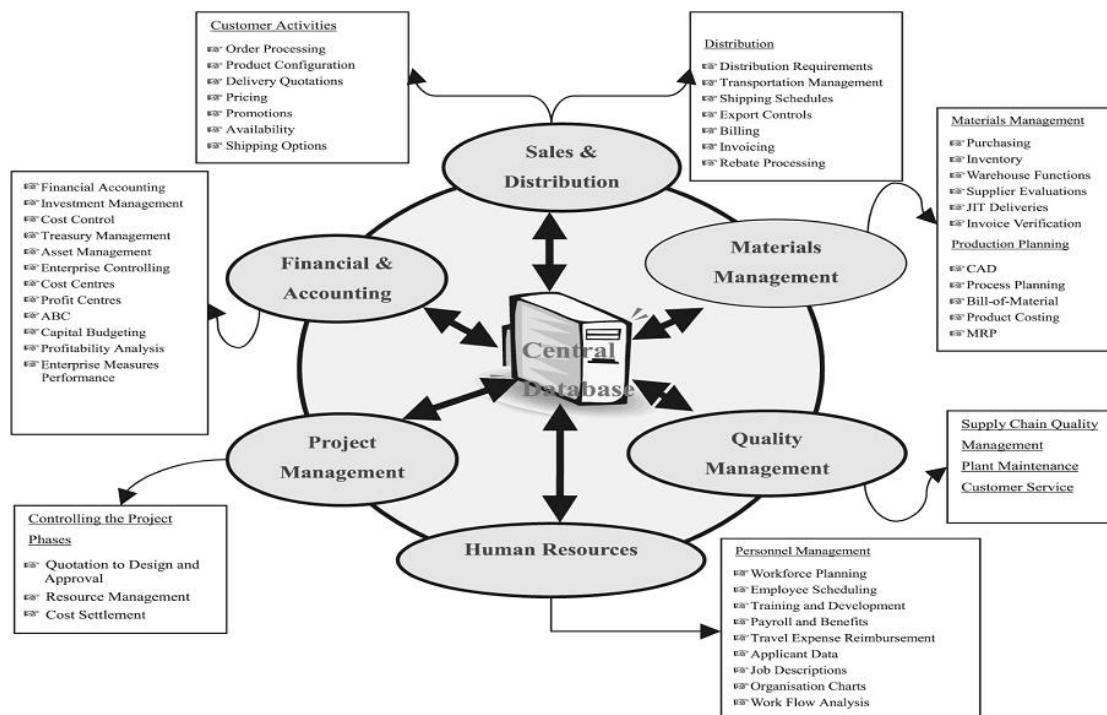

Fig. 1. ERP System [33]

In general, ERP differs from older legacy business applications in several distinct ways. First, ERP allows for a single view of the organization by providing an "information portrait" that touches every department and functional area within the enterprise [8][17]. Second, ERP offers the promise of data integration by using a centralized database for business information, such as human resources information, customer information, and business transactions [17]. Third, ERP facilitates increased connectivity among and between business processes via data and process integration [17]. Embedding standard business processes based on "best practice", ERP systems in many cases will not meet the unique needs of a particular organization. Thus, finding the right fit between ERP systems and the business processes of the target organization is critical for successful ERP implementation [12]. In the case of a misfit between the ERP system and the organization's established practices, the organization can respond by two approaches: ERP system customization or organizational adaptation [6][15]. An important decision is then the scale of ERP system customization and/or business process change that should be applied.

The ERP literature includes a number of studies exploring the issue of ERP system customization. Many studies recommend that ERP systems should be implemented with minimal customization [35][40], as ERP customization is problematic and may increase costs and limit maintainability [15]. Despite this, a number of studies have documented how ERP system customization may occur [19][25][26]. Reasons identified for this include resistance to change [26], functional misfit [5][19], and cultural differences [34][1].

3.1. ERP system customization

The primary goal of ERP system customization is to achieve a fit between an ERP system and the business processes of the organization [20], to fill the potential gap between ERP functionality and organizational requirements. Different conceptualizations of ERP system customization in former research include related terms such as tailoring [5], modification [26] and functional alignment [12] of the system. For example, based on a review of the ERP literature, and complemented by fieldwork and interviews with ERP vendors and consultants, Brehm [5] developed a framework of ERP tailoring options. The framework distinguishes between 9 different types of ERP package tailoring, ranging from "light" configuration up to "heavy" package code modification. When implementing an ERP system, an organization can choose to modify an ERP system by using almost any combination of the tailoring types [5]. The framework was further modified by Rothenberger [26] who grouped ERP modification options into three areas: configuration / selection, bolt-ons and system change. By selecting appropriate system components and setting parameters, an organization may configure a system to its needs. Since this may not accommodate all existing business needs, an organization may implement bolt-ons (or third-party packages) that supplement the ERP functionality, or build custom features on top of the ERP platform. Lastly, the ERP system code may be modified to fit the business needs [26].

According to an ERP report from Panorama Consulting in 2015 [24], only 7% of organization did not customize any aspect of their ERP system. An overwhelming 63% of organizations had some customization or significant customization.

3.2. Reasons for ERP customization

Minimal ERP customization has been reported as one critical success factor for ERP implementation [22][35][40], and some studies have documented how ERP projects applying customization have failed [11][15]. On the other hand, several studies have reported how ERP system customization has been applied by organizations [18][[25][26][34], also documenting positive results from this [7][12]. A frequently mentioned reason for ERP system customization is a functional misfit between the standard ERP system functionality and existing business processes [5][18]. The study by Light [19] discussed further potential reasons for ERP package customization. Besides functional misfit, several reasons for ERP system customization rooted in the influence of diverse social groups were identified. For example, ERP system customization may be performed because of a consultant's lack of knowledge about a product or its context, insufficient development work from the vendor, or as an act of safeguarding a work position by internal information systems personnel [19]

Zach and Munkvold, [44] identified seven possible reasons leading to ERP system customization, classified according to two phases of the ERP lifecycle (prior to "going-live" and after "going-live").

The reasons are resistance to change, unique business process, functional misfit, ownership type, motivation for the implementation, stage of growth, and maturity of the ERP system.

3.3. Categories of ERP customization

Gartner, Inc, 2013 [38] defines six categories of customizations to establish a differentiated approach. They are:
- Changes in User Interface (UI)
- Reports, Documents and Forms
- Workflows
- Integration to other applications
- Functionality extension
- Modifications of existing functionality

4. The Analytic Hierarchy Process (AHP)

Thomas Saaty, one of the pioneers of Operations Research, directs the research project for Arms Control and Disarmament Agency in the US State Department. Generous budget allows him to recruit some of the world's leading economists and games and utility theory. However, Saaty disappointed in the result of a team effort. Saaty [29] then remember: Two things stand out in my mind from that experience. The first is that the theories and models scientists are often too general and abstract to adapt to the specific needs tradeoff weapons. Difficult for those who are prepared to enter the US position their diverse concerns ... and to come up with practical answers and sharp. The second is that the US position was prepared by a lawyer who has a great understanding of the legal issues, but [that] is not better than the scientists in accessing the value of a weapon system to be traded off.

While teaching at the Wharton School, years later, Saaty was troubled by the communication difficulties he had observed between the scientists and lawyers and by the apparent lack of a practical systematic approach for priority setting and decision making. Then Saaty was motivated to attempt to develop a simple way to help ordinary people make complex decisions. The result was the Analytic Hierarchy Process (AHP) – a synthesis of existing concepts that attests to Saaty's genius through its power and simplicity.

Many of the world's leading information technology companies now use AHP in the form of decision models provided by the Gartner Group's and Decision Drivers. The American Society for Testing and Materials (ASTM) has adopted AHP as a standard practice for multiattribute decision analysis of investements related to buildings and building systems [2]. The AHP process is taught in numerous Universities and used extensively in organizations such as the Central Intelligence Agency that have carefully investigated AHP's theoretical underpinnings.

This method directs how to determine the priority of a set of alternatives and the relative importance of attributes in a multiple criteria decision making problem, and has been widely discussed in various aspects. For example, Schniederjans and Wilson [32] utilized the AHP method to determine the relative weights of attributes and applied these weights to a goal programming model for IS selection. Lai [16] conducted a case study to select a multimedia authoring system using the AHP method. Teltumbde [39] proposed a framework based on the Nominal Group Technique and AHP to select an ERP system.
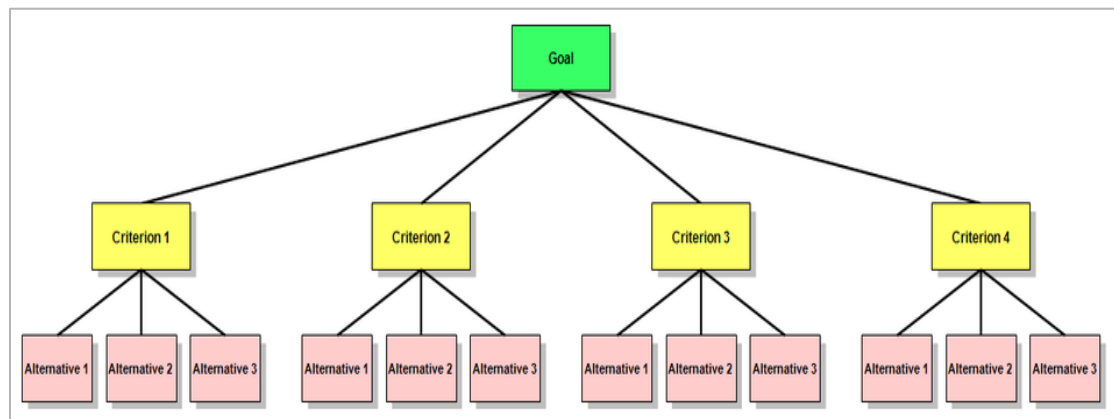

Fig. 2. A simple AHP hierarchy [41]

In this study, a systematic procedure is proposed to construct the objective structure taking into account company strategies and thus extract the associated criteria for evaluating ERP system customization methods. This study uses the analytical framework of AHP to synthesize decision makers tangible and intangible measures with respect to numerous competing objectives inherent in ERP system customization method and facilitates the group decision making process.

4.1. AHP applications

Decision situations to which the AHP can be applied include: [9]
1. Choice: The selection of one alternative from a given set of alternatives, usually where there are multiple decision criteria involved.
2. Ranking: Putting a set of alternatives in order from most to least desirable
3. Prioritization: Determining the relative merit of members of a set of alternatives, as opposed to selecting a single one or merely ranking them
4. Resource allocation: Apportioning resources among a set of alternatives
5. Benchmarking: Comparing the processes in one's own organization with those of other best-of-breed organizations
6. Quality management: Dealing with the multidimensional aspects of quality and quality improvement
7. Conflict resolution: Settling disputes between parties with apparently incompatible goals or positions [30]

4.2. AHP procedures

The procedure for using the AHP can be summarized as [28]:
8. Model the problem as a hierarchy containing the decision goal, the alternatives for reaching it, and the criteria for evaluating the alternatives.
9. Establish priorities among the elements of the hierarchy by making a series of judgments based on pairwise comparisons of the elements. For example, when comparing potential purchases of commercial real estate, the investors might say they prefer location over price and price over timing.
10.   Synthesize these judgments to yield a set of overall priorities for the hierarchy. This would combine the investors' judgments about location, price and timing for properties A, B, C, and D into overall priorities for each property.
11.   Check the consistency of the judgments.
12.   Come to a final decision based on the results of this process.

5. Practical example

The proposed framework was applied to ERP system customization method selection at company XYZ, one of project based company in Indonesia. The main business of this company is delivering System Integration, Managed Services and Data Center. Criterias and values of priorities are based on discussion with Business Process Owner of the ERP in the company. On the one hand, the fragmented modules of the existing ERP system limited the company's operating efficiency, caused much duplication of effort, and confused the business processes. On the other hand, the need to perform day-to-day operation in the highly dynamic business environment put increasingly heavy pressure on the company. In order to maintain its competitiveness, the top management announced the launch of a series of projects including the adoption of an ERP system and the reengineering of the complex business process to enhance the effectiveness of its businesses. In order to achieve the fit of ERP and business needs, customization of ERP is one of the main agenda. This research will analyze 2 methods of customizations :
• Single Vendor customization inside the ERP itself
    This is the common method used by ERP implementer around the world.
• Multi Vendor customization outside the ERP
    According to James Horne [13], In today's fast-paced, Web-driven world, the choice is no longer which system to implement, but when to implement each. And, as part of their investment decision process, product-developing companies must consider whether to opt for a single-vendor ERP

system, or to go with ERP and best-of-breed solutions. Most companies in the apparel industry are finding that combining best-of-breed solutions provides the desired visibility, with greater flexibility, and while encouraging greater excellence of execution. This isn't a common method, but as the experience of the author, this method was suggested to many organizations.

5.1. Model the problem as a hierarchy

As the decision makers continue with the AHP, they will determine priorities for the methods with respect to each of the decision criteria, and priorities for each of the criteria with respect to their importance in reaching the goal.

The priorities will then be combined throughout the hierarchy to give an overall priority for each method. The method with the highest priority will be the most suitable Alternative, and the ratios of the method's priorities will indicate their relative strengths with respect to the Goal.

The Goal is "Choosing the best method for ERP customization".

The identified criteria to be used in this research are:

- Commonality of demand: During the consulting process, consultant accepts customization because it is necessary for most enterprises and reflects the actual needs of the market throughout the discussion with customer.
- Complexity of demand: The actual needs of organization, fit with the business needs
- Flexible for future enhancement: The methods should be able to be enhanced, whether by IT Department of organization, or other vendor
- Ease to upgrade ERP System: the ERP should be easy to upgrade in the future
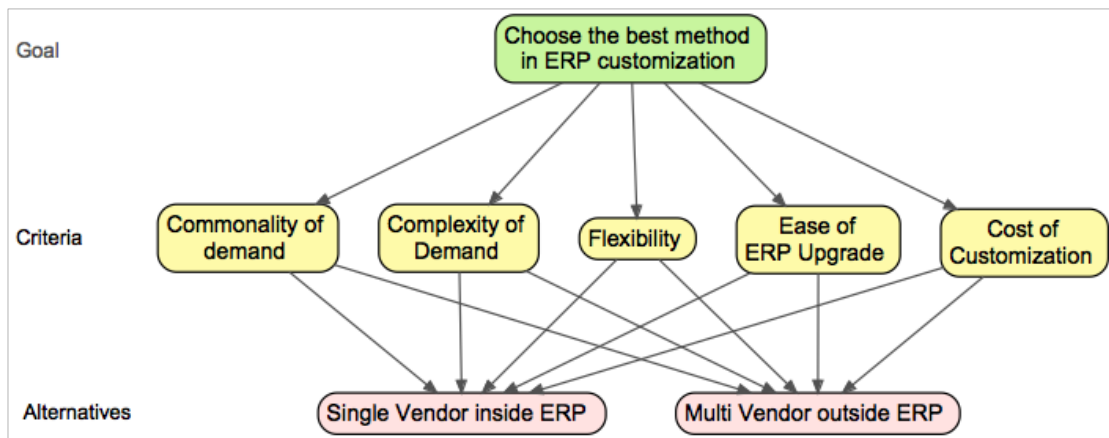- Cost of customization

Fig. 3. AHP Hierarchy for choosing the best method in ERP customization

5.2. Establish priorities

Priorities are numbers associated with the nodes of an AHP hierarchy. They represent the relative weights of the nodes in any group.

Like probabilities, priorities are absolute numbers between zero and one, without units or dimensions. A node with priority 0.200 has twice the weight in reaching the goal as one with priority 0.100, ten times the weight of one with priority 0.020, and so forth. While the amount entered in each criteria fields are based on score of alternative methods and scale of importance between 1 and 9.

This AHP steps will compare pairs of methods with respect to each criteria. For each comparison, the Business Process Owner decides which method is the weaker with respect to criteria, giving his experience a weight of 1. Then, using the AHP Fundamental Scale, assign a weight in each criteria of the other method.

The comparisons are summarized below. By processing this matrix mathematically, the AHP derives priorities for the methods with respect to criteria. The priorities are measurements of their relative strengths, derived from the judgments of the decision makers as entered into the matrix. These values can be calculated in many ways, including by hand, or with a spreadsheet program, or by using

specialized AHP software. The author uses BPMSG AHP priority calculator [4], and the results are shown below to the right of the matrix, along with an Inconsistency Factor computed by the specialized AHP software that was used to process the data.

Table 1. Alternatives compared with respect to Commonality demand.

Commonality of demand	Single Vendor inside	Multi Vendor outside	Priority
Single Vendor inside	1	3	0.75
Multi Vendor outside	1/3	1	0.25

Table 2. Alternatives compared with respect to Complexity of demand.

Complexity of demand	Single Vendor inside	Multi Vendor outside	Priority
Single Vendor inside	1	1/9	0.10
Multi Vendor outside	9	1	0.90

Table 3. Alternatives compared with respect to Flexibility.

Flexibility	Single Vendor inside	Multi Vendor outside	Priority
Single Vendor inside	1	1/7	0.125
Multi Vendor outside	7	1	0.875

Table 4. Alternatives compared with respect to Ease of ERP Upgrade.

Ease of ERP Upgrade	Single Vendor inside	Multi Vendor outside	Priority
Single Vendor inside	1	1/9	0.10
Multi Vendor outside	9	1	0.90

Table 5. Alternatives compared with respect to Cost of customization.

Cost of customization	Single Vendor inside	Multi Vendor outside	Priority
Single Vendor inside	1	1/3	0.25
Multi Vendor outside	3	1	0.75

Table 6. Criteria vs the Goal

Criteria	Commonality of demand	Complexity of demand	Flexibility	Ease of ERP Upgrade	Cost of customization	Priority
Commonality of demand	1	1/5	1/6	1/4	1/4	0.045
Complexity of demand	5	1	3	1/2	4	0.318
Flexibility	6	1/3	1	1/2	4	0.211
Ease of ERP Upgrade	4	2	2	1	2	0.320
Cost of customization	4	1/4	1/4	1/2	1	0.105

5.3. Synthesizing priorities

The calculations about priorities of alternatives with respect to the goal are as follows. This is a straightforward matter of multiplying and adding, carried out over the whole of the hierarchy.

Table 7. Calculation

Criteria	vs Goal	Alternative	A		B	C
Commonality of demand	0.045	Single Vendor Inside	0.75	x	0.045	0.033
		Multi Vendor Outside	0.25	x	0.045	0.012
						0.045
Complexity of demand	0.318	Single Vendor Inside	0.10	x	0.318	0.032
		Multi Vendor Outside	0.90	x	0.318	0.286
						0.318

Flexibility	0.211	Single Vendor Inside	0.125	x	0.211	0.026
		Multi Vendor Outside	0.875	x	0.211	0.185
						0.211
Ease of ERP Upgrade	0.320	Single Vendor Inside	0.10	x	0.320	0.032
		Multi Vendor Outside	0.90	x	0.320	0.288
						0.320
Cost of customization	0.105	Single Vendor Inside	0.25	x	0.105	0.026
		Multi Vendor Outside	0.75	x	0.105	0.079
						0.105

Column A shows the priority of this Alternative with respect to these Criteria. Column B shows the priority of these Criteria with respect to the Goal. Column C shows the product of the two, which is the global priority of this Alternative with respect to the Goal. Here are overall priorities for all of the alternatives:

Alternative	Commonality of demand	Complexity of demand	Flexibility	Ease of ERP Upgrade	Cost of customization	Goal
Single Vendor Inside	0.033	0.032	0.026	0.032	0.026	0.149
Multi Vendor Outside	0.012	0.286	0.185	0.288	0.079	0.850
Total	0.045	0.318	0.211	0.320	0.105	1.000

5.4. Decision

Based on the Business Process Owner's choice of decision criteria, on their judgments about the relative importance of each, and on their judgments about each methods with respect to each of the criteria, Multi Vendor Outside, with a priority of 0.850, is by far the most suitable approach. The organization should choose Multi Vendor Outside as the ERP customization method.

Because the use of the AHP, it is easy to trace criterias and to justify the steps along the way to the decision. If the organization have second thoughts about the final outcome, then it could be revisited the process and make changes if appropriate. And if the organization choose to, it can reveal the details of the process to the consultants and the shareholders, or to anyone else who might be concerned with the decision.

6. Conclusions

This research presents a comprehensive framework for selecting a suitable method for customizing ERP system based on an AHP-based decision analysis process. The proposed procedure allows organizations to identify the criteria of method selection and formulate the fundamental objective hierarchy.

The proposed comprehensive ERP customization method selection framework has the following advantages:
- It ensures that the structure of objectives is consistent with corporate goals and strategies.
- The approach is flexible enough to incorporate extra criteria or decision makers in the evaluation. Notably, the proposed framework can accelerate the reaching of consensus among multiple decision makers.
- The approach systematically assesses organization's criteria and guidance based on the organization's goals and strategic development. It can not only reduce costs during the selection phase, but also mitigate the resistance and invisible costs in the future.
- In case of unique business processes in other organizations, the criteria may differ from what this research was choosen. But the framework is easy to use in many kinds of criteria chosen by the organization.

Since the multi vendor customization outside the ERP system itself still less prestige than the big name of single vendor of ERP system, organizations should use this methods if they confident about

the criteria mentioned above. So, let the ERP system remains standard, this will give an advantage when upgrading is needed in the future. According to the research result, this is the most recommended method to get the best choice between the two.

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