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PREFACE

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IOT BASED SMART LAMP FOR EFFICIENT USAGE OF ELECTRICAL ENERGY

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Abstract. The government is proclaiming the electrical energy saving campaign in order to raise the people's awareness of its importance. The Ministry of Energy and Mineral Resources (ESDM Ministry) of the Republic of Indonesia stated that a year of energy saving equals to the amount of saving Rp43.000.000.000.000,00 (forty three trillion rupiah) of money, which is also equal to a construction of electric steam power plant with the capacity of 3.500 megawatts (MW). One of the programs that has been encouraged by the government is the 'turn off the light' campaign. Turning off lights is a simple but often neglected thing. Apart from the limited awareness to save the energy for a better future, people are often too busy to do it. In 2015, Taruna built an Arduino Micro-controller based light control system using Android smartphone to provide ease, specifically for physically disabled and elderly. The shortcomings of this system are that the lights cannot be turned on and off automatically (smart) with timer and it can only be controlled at close range (bluetooth). Development of technology with the internet guide can easily help human, and thus, this research aims to improve the system with the time control (timer) and close range control (bluetooth) as well as the long range using SMS and internet. The system is built with the prototype model that include the communication, fast planning, fast prototype designing and building, system submission and feedback. The result of this system building is that the light can be controlled using bluetooth and also provide a faster response time; less than a second (as well as the timer). The light can also be controlled from a long range using the internet connection, giving a response time between 14 to 17 seconds. When a light control command occurs, the SMS notification is sent to the cell phone of the user. Using this system, the light can be controlled correctly in order to conveniently give the user effectivity and efficiency in electrical energy usage.

Keywords : Android, Arduino, IoT, Smart, Web.

1. INTRODUCTION

The (Indonesian) government has been doing various innovations in order to save energy in Indonesia. In 2016, they launched an energy conservation program, using a jargon "Let's cut 10 percent" that invites people to conserve the usage of electrical power. This conservation program was proclaimed simultaneously in 20 major cities in 11 provinces. The minister of ESDM (Energy and Mineral Resources) at that time claimed that 10 percent of energy savings per year actually equals to Rp43.000.000.000.000,00 (forty three trillion rupiah) of money, and also equals to a construction of electric steam power plant with the capacity of 3.500 megawatts (MW). The Minister of ESDM added that there were three ways that the people could do in an effort to make an electrical energy saving from now on: First, turn off the lights and remove electronic equipment that is not being used and

remove the switch; second, hold the Air Conditioner (AC) temperature at 25 degrees; and third, to live an energy efficient lifestyle [1].

The Ministry of ESDM successfully organized the Earth Hour program in 2012. The campaign to turn off electricity for one hour from 20:30 to 21:30 saved electricity in Jakarta by 214 megawatts. Along with the activity entitled "This Is My Action, Where's Yours?", the ministry also gave 100 solar lights to the merchants around Central Park that were turned on simultaneously when the blackout was carried out. The objective of this campaign is none other than to save electricity, which also contributes to mitigating climate change [2].

Technology develops rapidly and unstoppably, producing new innovations in various line of human life, one of which is Smart Home. Smart Home is a branch of ubiquitous and pervasive computing, and also closely related to artificial intelligence that is used to increase the comfort factor, security, and energy savings in a house [3]. The internet is one of vital components in the development of Smart Home and the concept that has recently developed is the Internet of Things (IoT).

IoT can be described as the connector of everyday objects such as smartphones, internet television, sensors and controllers to the internet in which the intelligent devices are linked together to enable new forms of communication between people and those electronic devices [4]. Iot is a concept that aims to expand the benefits of internet connectivity that is continuously connected. As for the capabilities such as data sharing, remote control, etc., including objects in the real world such as food, electronics, any equipment, including living things, all of which are connected to local and global networks through sensors that are embedded and always active.

Taruna developed a Smart Home system, a home light control system based on the Arduino Microcontroller using an Android Smartphone. The developed system was able to provide convenience to residents, especially to those with disabilities who have moving limitation and the elderly. This system has the ability to turn on or off the lights using an Android Smartphone via Bluetooth media [5]. Andrianto and Arief developed the similar Smart Home system which is home lighting controllers, only difference is that theirs have remote control capabilities using Web media (internet) [6]. Astiyana, on the other hand, developed the same Smart Home system, namely remote home lighting controllers that uses SMS media [7].

Based on previous studies, there are still shortcomings that must be refined, one of which is combining 3 (three) media namely Bluetooth, Web / internet and SMS in 1 (one) system, so that the new system has more choices in its use. This study aims to combine the 3 (three) media above and add the ability to set the timer for automatic control of the lights, so that the lights can be turned on and off according to the specified time. With this system, the lights will not be turned on at an unnecessary time, especially when the user is too busy or forget to turn the light off and thus, will also help and support the energy-saving program by the government.

2. METHODS

Data collection in this study was carried out by literature study and interviews. Literature studies is all about studying the literature related to research topics, which is about how to build the system with various methods in order to support the research. The literature is obtained from various sources including scientific journals, research reports, magazines and books. The interviews are conducted by asking several questions to people who have sources of information and responsibilities needed in this study. Some people who are the users of electricity is also interviewed.

Prototype models are used in system development in this study. The development process of this system begins with the communication with prospective users, followed by rapid planning in the form of design modeling, then the building of prototypes, the next step is delivering the system to the user to obtain feedback, if the system is perfectly match with the needs of the user then the process is finished, otherwise if it is still not suitable then the process will continue to the initial stage and so on continuously.

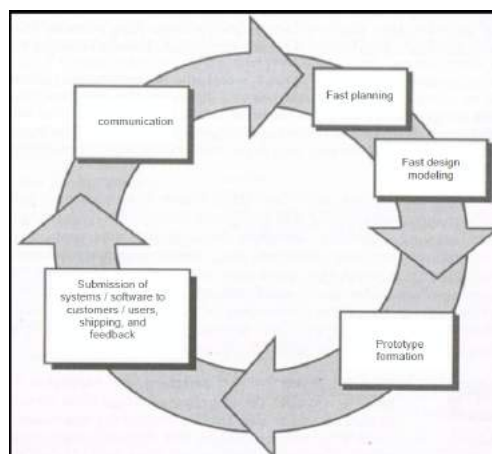


Figure 1. Prototype Model

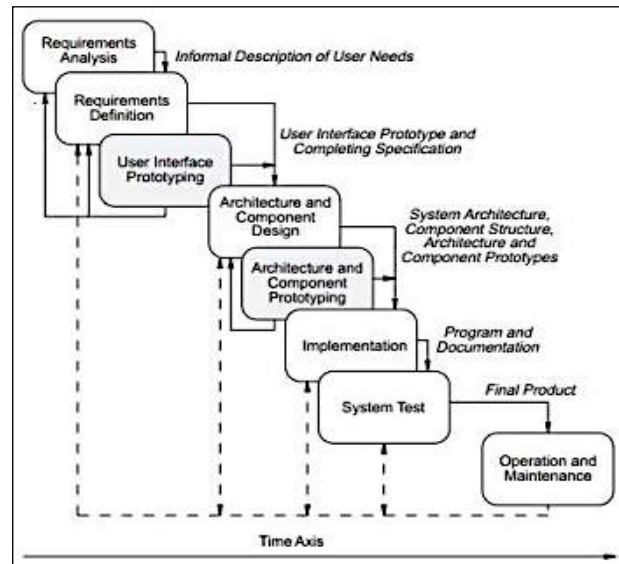


Figure 2. Prototype Model Flow Process
Source: Khosrow & Pour [8]

The implementation of the prototype model to the system built includes the design of the display that interprets the functions from each of the menu presented on the system and then displayed to several respondents to get feedback. Some designs can be seen in the following picture:

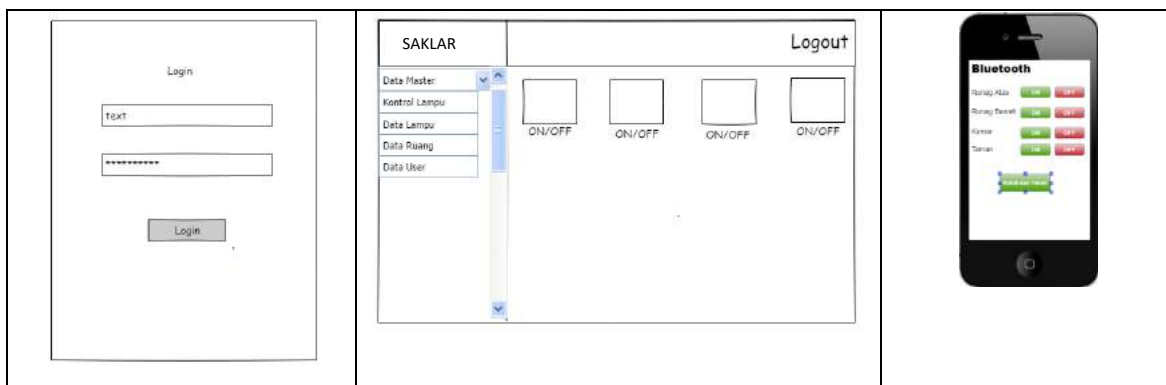


Figure 3. System Display Process

The building of system flow process in the prototype is also described as a flowchart to facilitate prospective users in understanding the system workflow functionality and in the form of Data Flow Diagrams (DFD) to describe the access rights of users. One of the control flowcharts via bluetooth and DFD can be seen in the following picture:

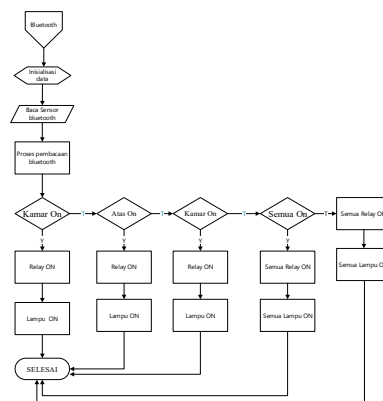


Figure 4. Prototype Flowchart Control

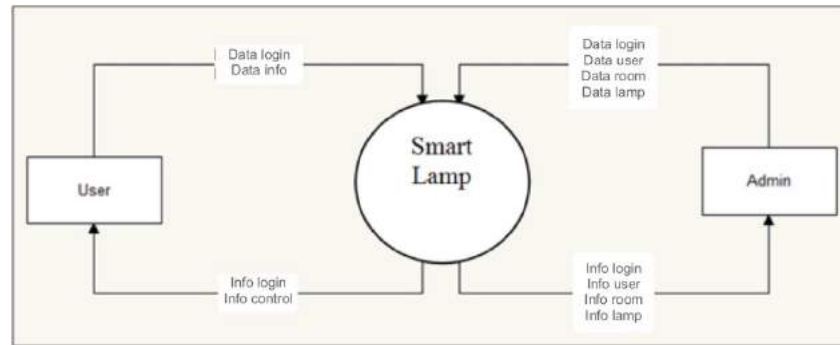


Figure 5. Prototype Flowchart Control

3. RESULTS AND DISCUSSION

The system built provides an alternative for the user to control the lights, including the access to control by time (timer) and with direct control (using bluetooth, web, sms). The illustration of system proposed can be seen in Picture 6:

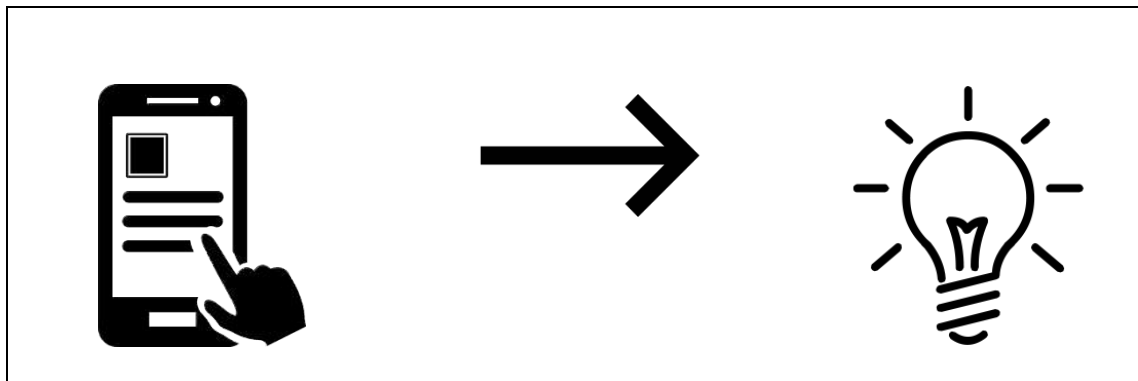


Figure 6. System Performance Building

The system architecture built consists of a sensor unit, sender, and output unit. The sensor unit consists of GSM, Bluetooth, and RTC which are directly connected to Arduino. The sender (unit) consists of Wemos, Modem Router, Android Smartphone, and internet network which will later be used in order to send data. While the output unit consists of relays and lights.

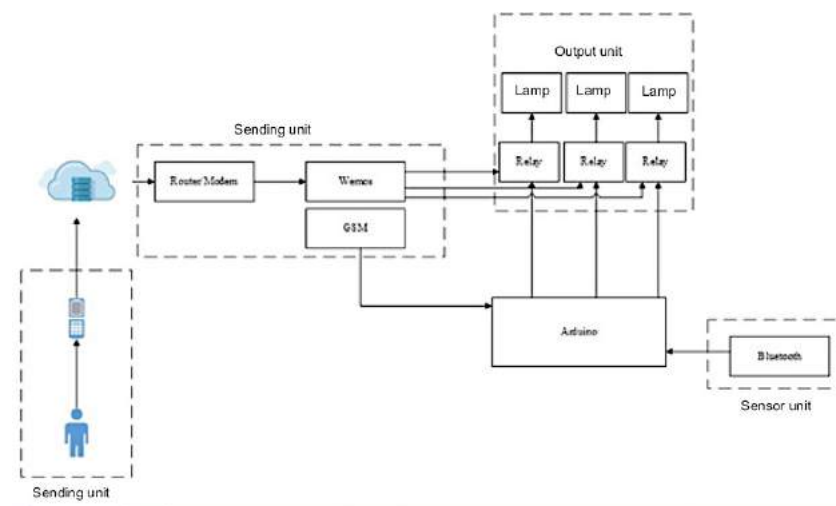


Figure 7. System Architecture Design

Context Diagram describes the role of users in general towards the system built. The system built has 2 (two) user levels, namely Admin and User. Each user has their own access rights, namely: Admin has access to manage data on space, lights and users and also able to operate or control the lights. While the users are limited to the operation or control of the lights only. Admin is the only one who can create a new User that is able to operate or control the lights.

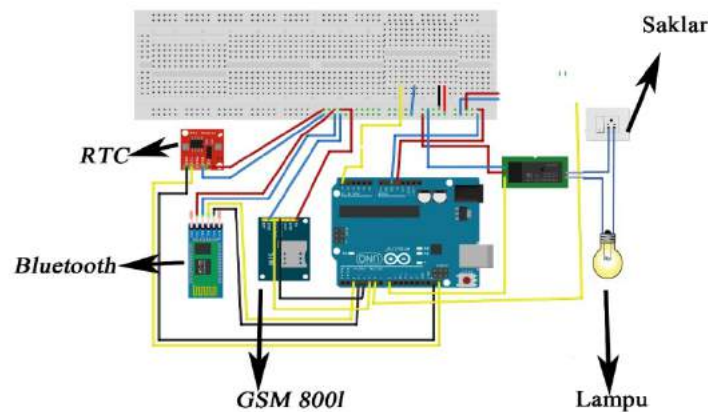


Figure 8. Hardware Schematic Design

Hardware Schematic Design describes the overall hardware circuit until the process ends at the light control. The LDR sensor is connected to Arduino using 2 jumper cables namely GND sensor to GND Arduino, and VCC sensor to VCC Arduino. The Bluetooth HC-05 module is connected to Arduino using 4 jumper cables namely GND Bluetooth to Arduino GND, VCC Bluetooth to Arduino VCC, RX Bluetooth to RX Arduino and TX Bluetooth to Arduino TX. The GSM module is connected to Arduino using 4 jumper cables namely GND GSM to Arduino GND, VCC GSM to VCC Arduino, RX GSM to RX Arduino and GSM TX to Arduino TX. IR is connected to Arduino using 3 jumper cables, namely GND sensor to Arduino GND, VCC sensor to Arduino VCC, and AO sensor to pin 3 on Arduino. 3 pieces of Relay are connected to Arduino through 9 jumper cables, namely GND relay to GND Arduino, VCC relay to VCC Arduino and IN relay to pins 7, 8, and 9 Arduino.

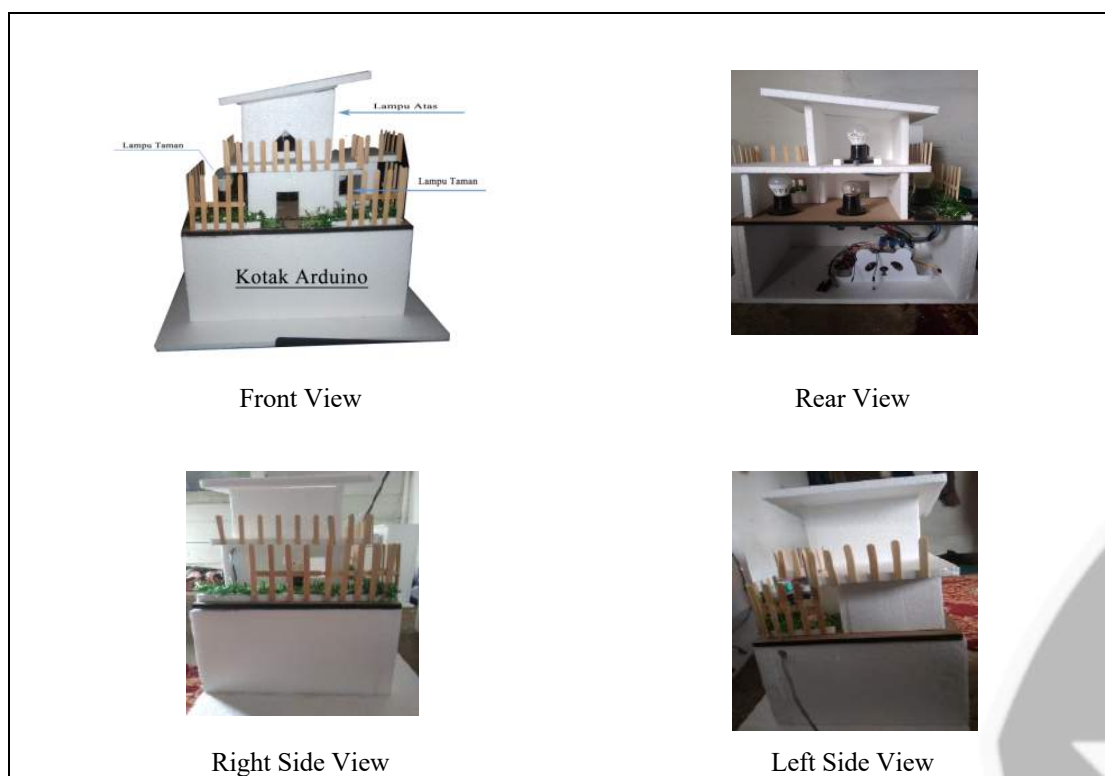


Figure 9. Hardware Implementation

The hardware implementation miniature can be seen in the picture above. The trial was conducted on 4 (four) lights which were divided into living room light, upper room light, bedroom light and garden light. Miniature hardware construction is located on the lower floor and can also be seen in the picture with the description "Rear View".

Software as an interface for Admin and User is built mainly by web-based with the PHP programming language and MySQL as its database. Through this web, Smart Lamp will be controlled by the User in order to turn the lights on or off. Implementation of the software can be seen in Figure 10:

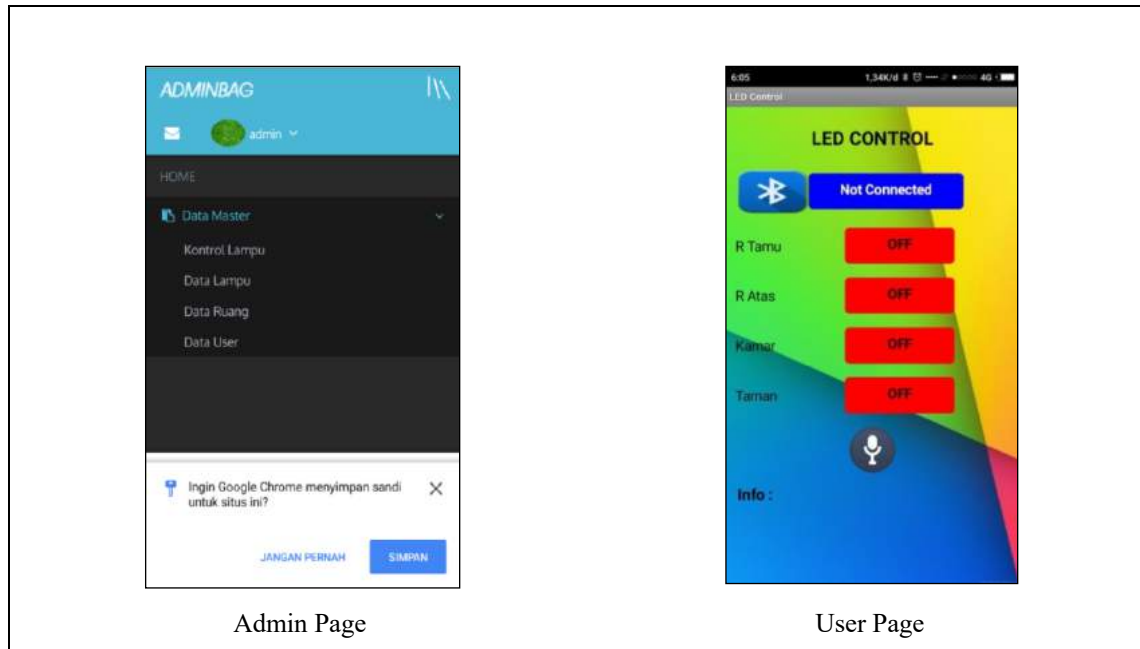


Figure 10. Software Implementation

The tests carried out on the system that has been built are carried out on each control component which includes bluetooth, timer, web and SMS notifications. The test results can be seen in Table 1.

Table 1. Control Component Testing

Control	Information
Bluetooth	Successful
Timer	Successful
Web	Successful
SMS	Successful

The tests are carried out in parallel, meaning that 1 (one) lamp can be controlled by 5 (five) components above and provide a notification in the form of SMS to each activity carried out by the User.

The control response to the lights by using Bluetooth media is relatively fast, which ranges from <1 second (less than one second). Besides that the response of the control to the Timer (RTC) is also quite fast according to the time set by the User. However, different results are shown by controls via the Web, which is above 10 (ten) seconds, or relatively slow. The response to the Web can be seen in Table 2:

Table 2 Response to the Web

Object	Second(s)	Average (second)
Living Room Light	11 17 16	14,6
Upper Room Light	18 14 17	16,3
Bedroom Light	17 21 25	21
Garden Light	11 18 15	14,6

This test is done by inserting a script on the Web to calculate the time like a Stopwatch tool. Each test is conducted 3 (three) times through the User. Based on the temporary analysis, this condition is influenced by the internet connection or availability of internet networks in the User environment, and thus affecting the fast or slow response of the lights.

According to the test result, the system built can run well and also give a positive impact in an effort to support the government to save the electricity usage. As a simple calculation, if the homeowner forgets or unable to turn off a 15-watt fluorescent lamp on their front yard for 1 hour per day in 1 month, the calculation can be assumed as follows:

$$0,015 \text{ kW} * 1 \text{ hour} * 30 = 0,45 \text{ kWh}$$

$$\text{Rp. } 996,74/\text{kWh} * 0,45 \text{ kWh} = \text{Rp. } 448,53$$

From the calculation above, there is actually a misuse of electricity of Rp. 448.53 when the homeowner neglects to turn off a lamp on his front yard for 1 hour per day in 1 month. The amount will certainly go up and be directly proportional if there are more lights that are neglected/not turned off in several houses. Using a system that is built according to this research, the condition above will not be happen and the users can actually save more electricity and energy for things that are useful.

4. CONCLUSION

Based on the results and tests of the system built, it can be concluded that the lights can be controlled at close range via bluetooth and can also be controlled remotely via the Web. User can also control or turn the lights on/off through the timer as desired by the user. Every activity carried out by one of the users will bring up the status notification light (on/off) in the form of an SMS to all Users registered by the admin. One light can be controlled by all media controls that have been built into this system. The system that has been built is able to help the electricity energy usage become more effective and efficient and able to contribute to energy-saving programs promoted by the government.

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MODIFICATION OF CaO CATALYST WITH IMPREGNATION METHOD USING KOH IN BIODIESEL SYNTHESIS FROM WASTE COOKING OIL

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Abstract. Chicken eggshells can be used as raw material in the manufacture of CaO catalysts. Increased CaO catalyst activity can be done by the impregnation method. The purpose of this study was to determine the effect of %K on the wet impregnation of CaO catalyst using KOH and to find out the impregnation catalyst (CaO / K₂O) on the biodiesel yield. Prepared chicken egg shells were calcined at 900°C for 3 hours. Then the CaO obtained was impregnated using KOH with a variation of % K (5%, 7%, 9% and 12% (w / w)) while heated at 85°C. The impregnation product was calcined at 600°C for 5 hours. The impregnation catalyst (CaO K₂O) was applied to the biodiesel synthesis through a transesterification reaction with a mole ratio of 1:12 waste cooking oil: methanol, the amount of catalyst was 1.5% at a reaction temperature of 70°C for 2.5 hours. Based on the results of SEM-EDS analysis, the highest K₂O at 7% K was 21.99%, while the highest CaO content was at 9% K by 81.53%. For the highest surface area analysis at 7% K with a surface area of 71.22 m² / g, alkalinity was 2.59 mmol / g. The best biodiesel was obtained with a yield of 87.17%, kinematic viscosity of 2.89 cSt, water content of 0.032%, density of 0.819 g/ml, methyl ester level of 99.39%.

Keywords : Biodiesel, Impregnation CaO,, Transesterification, Waste Cooking Oil.

1. INTRODUCTION

Catalysts are compounds that accelerate reactions. The catalyst was divided into three, namely homogeneous catalyst, heterogeneous catalyst, and biocatalyst. In making a compound generally a homogeneous catalyst and heterogeneous catalyst are used. The disadvantage of a homogeneous catalyst is that it is difficult to separate from the solution of the process. Homogeneous catalysts also cannot be reused and will become hazardous waste if disposed directly. To avoid this weakness, therefore, heterogeneous catalysts are used.

CaO catalyst is a heterogeneous base catalyst which has been widely used because of its benefits, such as mild reaction conditions, relatively economical, a good alternative in the process of making biodiesel. Heterogeneous base catalysts can be easily separated from the reaction mixture so that they can be reused, and the impact is less on the environment and their solubility is lower in biodiesel [1-3]. CaO is made by calcining eggshells above a temperature of 600°C. Efforts made to improve the performance of the catalyst are by adding active sites in the form of bases with the impregnation method. Impregnation method aims to increase basicity by inserting metal into the catalyst.

Researches on the combination of CaO catalysts with other metal catalysts have been carried out, such as CaO / ZnO, CaO / Al₂O₃, CaO / Li and CaO / KF because it can increase catalytic activity, and can reduce the formation of soap in biodiesel production. In addition, the metal that can be used for impregnation is potassium (K) metal from KOH. KOH was chosen because the price is relatively cheap and easy to obtain. The CaO catalyst that has been impregnated can be used in the transesterification reaction in making biodiesel. Impregnation of CaO catalyst with KOH has been carried out with clam shell as a raw material, the best results were obtained on the addition of 5% KOH. However, based on analysis with XRD, there was still a component of CaCO₃ which

dominated after calcination. This was because the shells have a very hard layer. The biodiesel yield obtained was 81.5% with a catalyst weight of 3% of the weight, reaction temperature of 60°C and reaction time of 3 hours [4]. Another study on the manufacture of CaO / C / KOH catalyst with wet impregnation method and applied to the manufacture of biodiesel from soybean oil, the best results of the catalyst at the addition of 25% KOH with biodiesel yield of 98%, reaction temperature of 65°C, catalyst amount of 1.5% from total weight of oil [5].

For this reason, the impregnation of CaO catalyst from chicken egg shells using KOH will be varied in the concentration, accompanied by stirring and heating at 85°C and its application to the manufacture of biodiesel with waste cooking oil.

2. METHODS

Material

The materials used, which are waste cooking oil and chicken egg shells, are obtained from street vendors around Samarinda, indicators of phenolptalein, NaOH 0.1 N, KOH, ethanol p.a, methanol p.a, aquadest and universal indicator paper.

Preparation of catalyst raw materials

Weighing 1000 grams of egg shells, washing with water until clean and drying them in the oven at 110 °C for 24 hours. Then breaking the egg shell to powder and screening with a sieve of -200 + 325 mesh. Then the eggshell powder was calcined at 900 °C for 3 hours. The calcination results were then stored in the desiccator to keep the catalyst condition dry.

Manufacture of catalyst CaO/K₂O

As much as 50 grams of CaO from the first calcination was dissolved in 200 mL of KOH solution with variations of 0%, 5%, 7%, 9% and 12%, then impregnated by heating the mixture with a temperature of 85oC while being stirred until dry. The impregnated catalyst was then dried in an oven at 105oC for 24 hours, then calcined at 600°C for 5 hours. The impregnated catalyst was analyzed for its basicity, BET, SEM EDX and XRD.

Esterification Reaction on Waste Cooking Oil

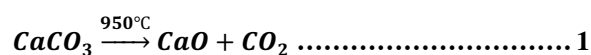
Heating the waste cooking oil that has been weighed before to a temperature of 60°C. Mixing waste cooking oil with 40 grams of methanol and 1 gram of H₂SO₄. Reacting them for 1 hour, keeping the mixture temperature at 60°C. Inserting it into a separating funnel and letting it sit for 1 hour, then taking the triglycerides at the bottom layer.

Transesterification Reaction (Biodiesel)

Weighing 1.5% of the weight of CaO / K₂O catalyst oil which was previously impregnated with a variety of % K into a round bottom flask. Adding methanol then stirring for 60 minutes. Inserting waste cooking oil into a round bottom flask (ratio 1:12 with methanol). Increasing the temperature to 65°C then refluxing it for about 3 hours. Cooling the reflux results then separating the reflux results with CaO catalyst. Inserting the mixture into a separating funnel and storing it at room temperature for 1 hour then separating between the top layer and the bottom layer. Washing the top layer with ± 80°C temperature water. Next evaporating the water content contained in biodiesel at a temperature of 105°C. Analyzing the biodiesel products produced includes GC-MS, density, kinematic viscosity, water content, yield, and flash point analyses.

3. RESULTS AND DISCUSSION

The manufacture of CaO catalyst is done by calcining the eggshells that have been washed and dried. The purpose of eggshells calcination is to remove carbonate dioxide compounds through the decomposition reaction of calcium carbonate contained in eggshells to obtain calcium oxide compounds. In this study, calcination of eggshells is carried out for 3 hours at a temperature of 900°C. The reactions that occur in the calcination process are:



From the calcium oxide compounds obtained then impregnation process is carried out using KOH. Impregnation aims to increase the catalytic activity of the catalyst. The principle of impregnation is to enter the precursor into the support pore (catalyst) while stirring and heating. This will affect the characteristics of the catalyst, namely basicity, surface area, morphological shape, and composition of the catalyst.

Basicity

One way to increase catalytic activity is to increase alkalinity. Basicity can be improved by the impregnation method. KOH is used as a precursor for the impregnation process on CaO catalysts. The impregnation process causes the basicity of the catalyst to increase. The greater the basicity of the catalyst, the more the catalytic activity of the catalyst will increase [4]. Basicity before and after impregnation can be seen in Figure 1.

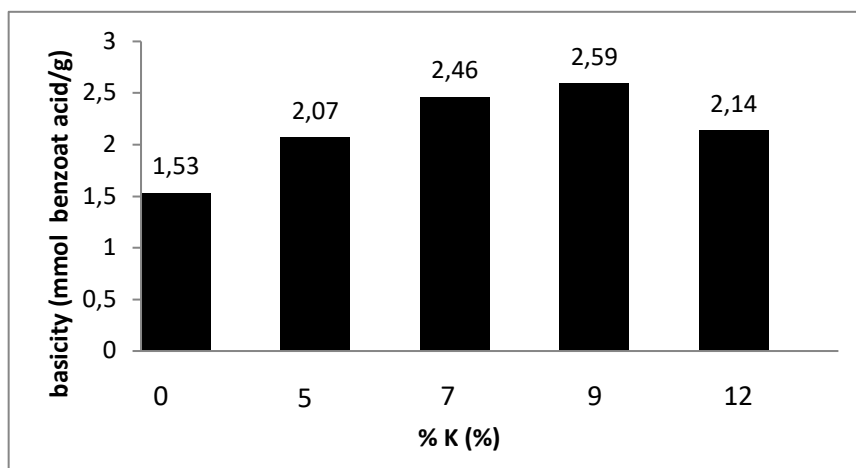


Figure 1. Effect of % K on basicity

Determination of the basicity of the impregnation catalyst using the acid-base titration method, before impregnation, basicity of the catalyst was 1.53 mmol benzoic acid / g. After impregnation, the catalyst alkalinity increased to 2.07-2.59 mmol benzoic acid / g. The decrease of alkalinity is at 12% K, this is due to the distribution of K metal in CaO pores which is not evenly distributed and is also caused by stirrers that are too small so they cannot reach the entire surface of the beaker in the impregnation process and the solution becomes very thick so that the stirring is done manually and samples attach to beakers that are difficult to separate.

Surface area

The surface area of the CaO impregnation catalyst is determined by the compounds contained therein and the compounds that cover the pores of the catalyst. The surface area of the catalyst can be seen in Figure 2.

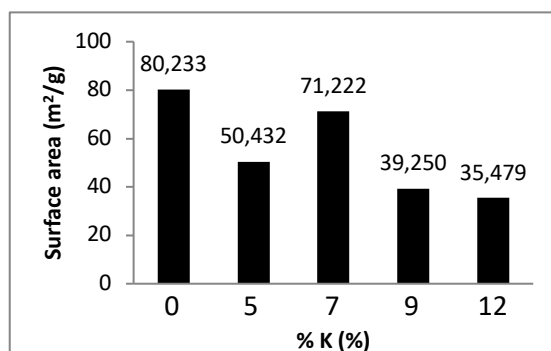


Figure 2. Effect of % K on Catalyst Surface Area

The catalyst before impregnation had the largest surface area of 80.233 m² / g, compared to the catalyst after impregnation. According to [4], the pores of CaO are filled with K₂O and K₂CO₃, causing a decrease in surface area. The decrease in surface area is also caused by the formation of Ca (OH)₂. The size of the surface area is directly proportional to K content except in the variation of 12%.

SEM-EDX

The effect of variations in % K on the impregnation process can be seen by using SEM-EDX analysis. SEM aims to see the shape of the sample surface and EDX aims to see the chemical components of the catalyst. The shape of the surface of the catalyst can be seen in Figure 3 and the composition of the catalyst can be seen in Table 1.

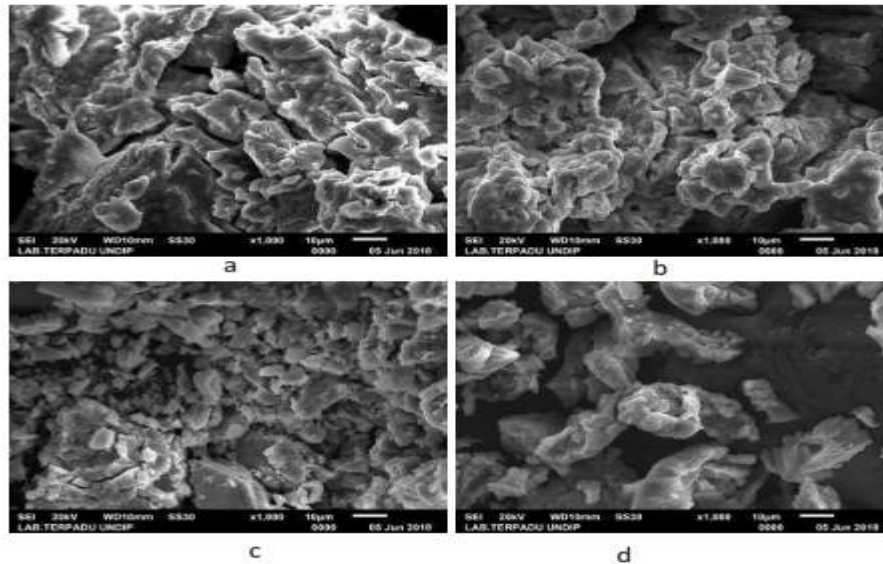
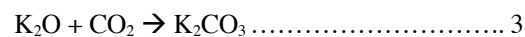
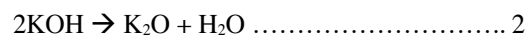


Figure 3. The surface of the catalyst through SEM. A) 5%, b) 7%, c) 9%, d) 12%

The shape of the catalyst surface in each % K looks different in Figure 3. The difference in surface shape is influenced by differences in the composition of the catalyst.

The imperfections of the impregnation process and the effect of the second calcination temperature cause differences in the composition of each variation of % K. This is because the KOH compound is not only converted into K_2O compounds but also forms K_2CO_3 compounds. At temperatures of $300^\circ C$, KOH will be converted to K_2O , H_2O , and K_2CO_3 [6], by reaction:



At temperatures above $427^\circ C$, the melted KOH will react with carbon compounds to form K_2O and K_2CO_3 by reaction:



Table 1. CaO impregnation (SEM-EDX) catalyst composition

K (%)	component	composition(% wt)	K (%)	Component	composition (% wt)
5	C	21,11	9	K_2O	4,38
	MgO	1,59		CaO	81,53
	K_2O	12,73			
	CaO	64,46			
7	C	25,72	12	C	39,53
	MgO	2,71		MgO	1,01
	K_2O	21,99		K_2O	9,58
	CaO	46,72		CaO	45,98

Application of CaO / K₂O Catalyst in Biodiesel Synthesis

The initial stage in making biodiesel is analyzing the levels of free fatty acids and kinematic viscosity from waste cooking oil which is used as a raw material for making biodiesel. Free fatty acids are very influential in the process of making biodiesel because the high free fatty acids contained in oil samples will react with alkaline catalysts to form soap, because bases will react to neutralize free fatty acids from oil [6], while viscosity analysis which is done to see the viscosity of the oil itself can be compared with the biodiesel obtained. From the analysis of free fatty acid content, the free fatty acid content in the oil sample was 0.74% and kinematic viscosity was 33.09 cst. The aesthetic reaction does not need to be done, because the reaction serves to reduce the levels of free fatty acids contained in oil while the oil requirements used as a raw material for making biodiesel are free fatty acid levels of less than 5% [7].

In the transcription reaction, the catalyst is first reacted with methanol to form a methoxy species which are the initiator of the transesterification reaction. The reaction mechanism is listed in the reaction below:



The transesterification reaction is carried out at a temperature of 62 - 65 ° C for 3 hours, 3 layers consisting of catalyst, glycerol and biodiesel are obtained. The catalyst and glycerol layers are separated, then the upper layer is washed using a warm aquadest (± 80 ° C). The washing process is repeated until the washing layer is clear and the pH of the washing layer is the same as the aquadest pH used as washing water. This repeated washing aims to remove glycerol, methanol, and catalysts which are still contained in biodiesel. The washed biodiesel is then heated at 105°C for 30 minutes to remove the remaining washing water.

Characteristics of methyl esters from waste cooking oil

The characteristics of methyl esters which consist of density, kinematic viscosity, and moisture content can be seen in table 2 below

Table 2. Analysis results of density, viscosity, water content and yield of biodiesel

catalyst (%)	Density(g/mL)	Kinematic Viscosity (cst)	Water Content (%)	Yield (%)
0	0.8715	5.38	0.034	49.69
5	0.8644	3.53	0.0459	47.75
7	0.8599	2.89	0.032	87.17
9	0.8672	4.13	0.046	60.165
12	0.8936	16.64	0.0419	72.75

Based on Table 2, it is known that the biodiesel water content has met the SNI specification regarding biodiesel quality requirements which is less than 0.05%, while the parameters for kinematic density and viscosity for biodiesel obtained using catalysts with 12% K concentration at CaO still exceed SNI standards. This is because there are still remaining catalysts floating in the biodiesel washing process so that the remaining catalyst can react with fatty acids to form soap or biodiesel which is formed to undergo reaction again with the catalyst so that the reaction shifts towards the reactants.

The mole ratio of oil to methanol is one of the most influential factors in the transesterification process. In general, the transesterification reaction requires 3 moles of alcohol and 1 mole of triglycerides to produce 3 moles of fatty esters and 1 mole of glycerol. In this study, a ratio of 1:12 (Oil: Methanol) is used. The use of excess methanol is intended so that the equilibrium reaction shifts more towards the product because the transesterification reaction is an alternating reaction. The best results were obtained with the yield of 87.17% with a K catalyst of 7% and the methyl ester of 99.39% based on GC-MS analysis.

4. CONCLUSION

Based on the results of the research that has been done, conclusions can be drawn as follows:

1. From the analysis of the CaO / K₂O catalyst; SEM-EDS analysis showed that the content of CaO and K₂O as follows: K₂O was the highest in the variation of 7% K at 21.99%), while the highest CaO content at 9% K was 81.53%. In surface area analysis, it was found that the highest surface area was at 7% K with surface area of 71.22 m² / g and alkalinity of 2.59 mmol / g.
2. The best biodiesel product was with yield of 87.17%, kinematic viscosity of 2.89 cSt, moisture content of 0.032%, density 0.819 g / ml, and methyl ester content of 99.39%.

5. ACKNOWLEDGEMENT

The sincere gratitude goes to the Directorate of Research and Community Service, Directorate General of Strengthening Research and Development at the Ministry of Research, Technology and Higher Education with No. Contract: 862f / PL7 / LK / 2018 which has provided the National Strategic Research Grant

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ORGANIC WASTE CHOPPER TOOL DESIGN USING AUTODESK INVENTOR 2015 SOFTWARE

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Abstract. Autodesk inventor is very suitable to be applied in mechanical component design work, mechanical system design to mechanical strength analysis of mechanical components designed. The problem of this research is how to make the Design of Organic Waste Chopper Tool by using the 2015 Autodesk Inventor Software, and whether the design of the tools made can simplify the process. This research method is to make the Organic Waste Chopper Tool design using the 2015 Autodesk Inventor program which is used to accelerate the process of designing design drawings. The design for making organic waste calculators includes making parts, 3D image components, assembly work drawings, and animations. Therefore, it was concluded that: (a) Manufacture of organic waste chopper design, the first is a design idea, then the drawing process using the 2015 autodesk inventory program includes sketching, drawing components of machine parts, followed by assembly, then rendering and animation. The final stage of the design was included in the "IDW" complete with size, scale, material, work drawings making it easier for designers to make tools, (b) The design of the Organic Waste Chopper Tool using the Autodesk 2015 Inventor Software can simplify the process, (c) Design specifications for Organic Waste Chopper tool are: Multi-Function Waste Counting Machine 01, Capacity 50 kg / hour, Blade type 10 fixed seeds, 27 seeds move 3 seeds, Circule Church 1 seed, 1 inch shaft, FrameUnp 5, Type V - A43 Belt, and V-Block Bearing UCP 6205.

Keywords : Software, Autodesk Inventor, Scale, Dimension, Assembly.

1. INTRODUCTION

Autodesk inventor is a CAD software in mechanical engineering program that is applied to the design of mechanics in 3D. Autodesk Inventor is software specifically designed for the needs of engineering programs such as product design, machinery design, construction design, or other engineering products. This software is a series of refinement software from Autocad and Autodesk Mechanical Desktop [1,2]. This software is perfect for Autodesk Autocad users who want to improve their capabilities because this software has almost the same concept in 3D drawing. Autodesk inventor is one of the CAD (Computer Aided Drawing and Design) software released by an American company called Autodesk. As CAD software, the design steps of a tool include the scale, dimensions, and materials used in the tool [3,4]. Therefore, every planning of making a tool must be based on planning a design [5].

Basically, from the description above, it will be easier to do the depiction using Autodesk Inventor software, so to be need tries to raise the issue about "Organic Waste Chopper Tool Design". Autodesk inventor is very suitable to be applied in mechanical component design work, mechanical system design to mechanical strength analysis of mechanical components designed.

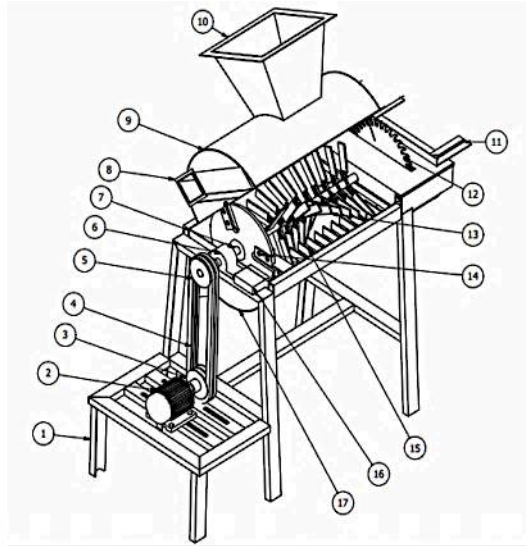
Based on the description above, the problem is how to make the Design of Organic Waste Chopper Tool by using the 2015 Autodesk Inventor Software, and whether the design of the tools made can simplify the process.

The purpose of this research is to be able to make the design of Organic Waste Chopper Tool by using 2015 Autodesk Inventor Software, as well as knowing the phase of design both in 3D, working drawings, assembly and animation methods.

2. METHODS

2.1 Design Planning

The 2015 Autodesk Inventor program was used to speed up the process of designing design drawings [6,7]. The design of the design for making this organic waste counter tool includes the creation of parts, 3D image components, assembly work drawings and animations (like figure 1).



Information:

1. Frame
2. Electric Motor
3. Pulley
4. V-belt
5. Waste Chimney
6. Bearing
7. Axis
8. Branch entry chimney
9. Upper Cylinder
10. Leaf Chopper Chimney
11. Wood Cutter Set
12. Circular saw
13. Leaf chopper knife
14. Branch cutter knife
15. Motionless knife
16. Cut distance adjustment
17. Lower Cylinder

Figure 1. Organic Waste Chopper Tool Design Plan

The specifications of the tool are planned: The main driver is 220v electric motor, V-belt transmission, U channel iron frame, blade chopper blade model, eser plate casing, capacity 50kg / hour, dimensions 90cm x 40cm x 120cm, weight 180kg.

2.2 Location and Time of Design Making

Design location in the Lab. Computer Design Program of Mechanical Engineering, Politeknik Negeri Bali. Time to carry out 5-month design making (March to July 2017).

2.3 Determination of Data Sources

The data source is obtained from the results of the survey with Ergonomic design, analyze and adjust towards Anthropometric Standards, safety, security, comfort, and aspects related to human physiology, as well as from the Mechanical Engineering Drawing literature by using the 2015 Autodesk Inventor program [8].

3. RESULTS AND DISCUSSION

3.1 Design

How to make a design of an Organic Waste Chopper Tool by using the 2015 Autodesk Inventor Software, through several steps, consisting of:

- (a) Frame Design

Click new then select metric then look for standard (mm) like figure 2, then click create then select one of the axis of the plane,

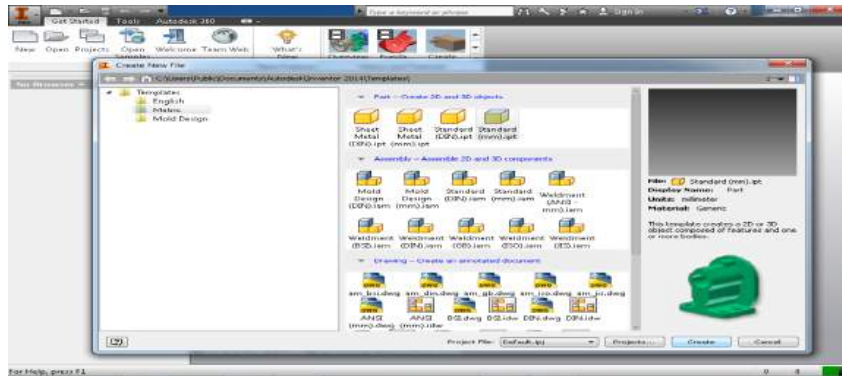


Figure 2. Main Menu

then create a sketch, then open the origin, select the xy plane then drag along 660 mm, and make the sketch according to the image size, open the origin again, select the pull up xz plane along 750 mm then create new, make the sketch according to the image then click finish, like Figure 3.

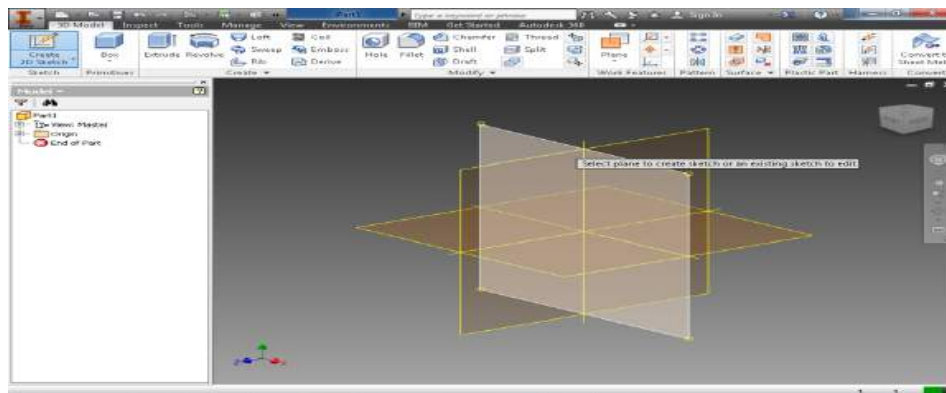


Figure 3. Plane Axis

After finishing sketch, open origin, select the pull up xz plane along 280 mm then click Create new sketch then create a design pattern, open the origin again, select the xy plane then drag along 1000 mm and click Create new sketch in the work plane created then create sketch according to the image then click finish sketch, then click new sketch in work plane 3 in the browser bar, then make sketch according to the design, then click after finish sketch.

Then click new sketch in work plane 3 in the browser bar, then make sketch according to the image with a length of 410 mm so that you can design the desired one, then click save then the file name is saved with the name "order" then click save. Then click new select metric then select standard (mm), then click create, then click place select the file "order". Then click open, then click the menu bar then click insert frame and click yes on the generator frame menu, continue click save. Make file with file name "frame assembly" then click save. After the save menu appears insert in the frame member selection menu select the size variant according to the design that will be made. Then click the sketch line that will be made the frame continue click ok on the create new frame menu, after the save menu appears insert in the frame member selection menu select the size variant according to the design that will be made. Then click the sketch line to be created, click ok on the frame member name. After the save menu appears insert in the frame member selection menu select the size variant according to the design that will be made. Then click the line of the image that will be made the frame, click ok on the frame member name which is the finished frame image then right click on the frame located on the left browser bar then click visibility and the following view is already visibility, then click the design menu then select change to change the position of the frame so that the change menu appears then select the frame we will change its position. Here is the frame view that we have changed. Then select the design menu then click the miter corner which functions as making angles on two frames, then displaying two frames who have cornered and also displayed the frame that

has been mitered, then select the design menu then click trim and extend to face which functions as cutting or lengthening the frame to one of the frame fields, then clicking the trim or extend menu on the select frame member menu we select the blue and face or surface we click the yellow part then click apply, then will trim-extend the other frames, then double-click left on one of the frames that will be sketched, then click the new sketch in the previous frame then make the sketch match the image, then extrude the sketch previously made to make the bolt holes in the frame then click ok, and click the save icon, save the file with the Assembly Frame name and click save (like Figure 4).

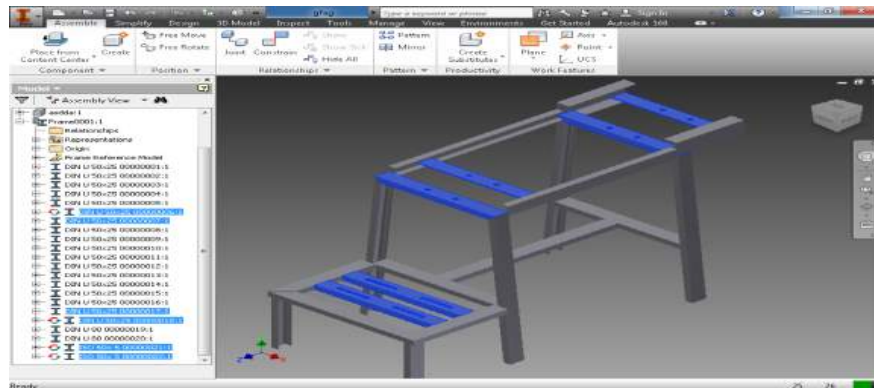


Figure 4. Framework

(b) Upper Casing Design

For the top tube design, first click new then select metric then look for metal sheet (mm). Then click create, then select one axis of the plane and make sketch according to the image then finish sketch, then click contour flange then change distance to 600 mm, continue to click unfold to make the image become a stretched image, then sketch on the stretched image to make an inlet of organic waste, then click the cut menu bar then click the sketch that was created then ok, then click refold to restore the stretched image to its original state. To see the results of the image in the form of a stretch image click "go to plate petren". To reverse part click "go to folded part" on the top right menu then save the ipt file in a folder with the top case name then click save.

(c) Leaf Chopper Casing Design

Click new then select metric then look for standard (mm). Click click create then select one of the axis of the plane and then make the sketch according to the image then click finish sketch, then open origin click the xy plane then drag up along 25 mm, then right click on the work plane. Then make the sketch according to the image then click finish sketch and then click Loft on the menu bar then on the menu section click icon 1 and icon 2 then click ok. Then click the shell on the menu bar to make solid objects become hollow, set the thickness of the sides as thick as 2 mm then click ok, then click the new sketch in the upper field then make the sketch according to the image then click finish sketch, then click extrude on the menu bar then click sketch the new one is made to make 2 dimensions into 3 dimensions then set the distortion along 2 mm, click ok, then click origin then right click on the xy plane then click new sketch then make sketch according to the image then click finish sketch, then click extrude then select extends all cut icon with 2-way cut and click save with file name casing leaf counter.

(d) Branch Cutter Casing Design

the steps for making the image are almost the same as making the drawing of the leaf chopper casing.

(e) Assembly Upper Casing Component

Click new then select standard click metric (mm). Then create, continue click place on the menu bar, then click the component file we want to assemble then click open then the file is opened, Part appears in the assembly menu then right click ok, then click constrain, in selection 1 click radius from the tube cap in selection 2 click on the side of the tube and the two components will merge into one, then click ok then click the save icon to save the file name, (like Figure 5).

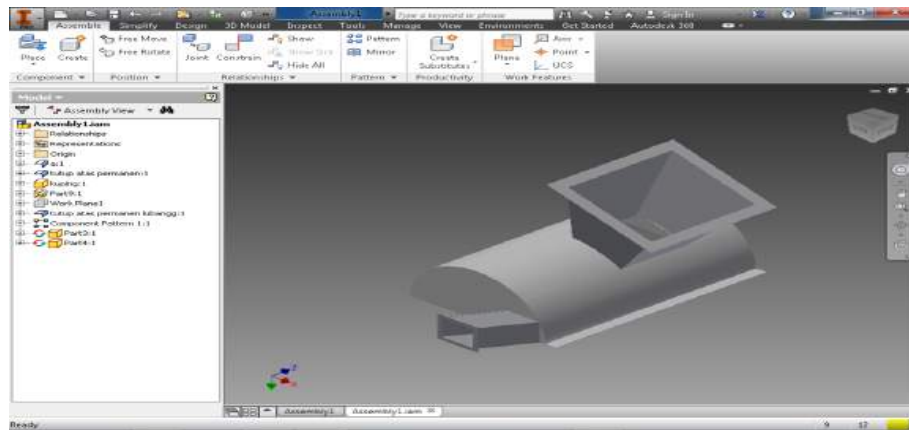


Figure 5. Assembly Upper Casing

(f) Lower Casing Design

At the lower casing steps to make the drawing is almost the same as making the upper casing design drawings with different 2 holes.

(g) Waste Casing Design

Click new then select *metric* then look for *sheet metal* (mm) .ipt then click *create* then select one of the axis of the plane and make *sketch* according to the image then click **face** on the menu bar then click *profile* and click the newly created *sketch* then click *ok*, then click *icon flange* on the *edge column* select one side that will add the length of the plate with a length of 120 mm, and click the next side then click *flange* along 175 mm, then click *unfold* to see the stretch of part, then click the *new sketch* on the surface of the part and make the sketch according to the image, then click the cut icon then click the new sketch then click *ok*. Then click *refold* to restore the stretch image to its original state and click "go to plate pattern" and click the save icon to save the *file name*.

(h) Assembly Lower Casing Component

For the assembly of the lower casing components the steps for making the drawing are almost the same as making an image of the upper casing component assembly, (like Figure 6).

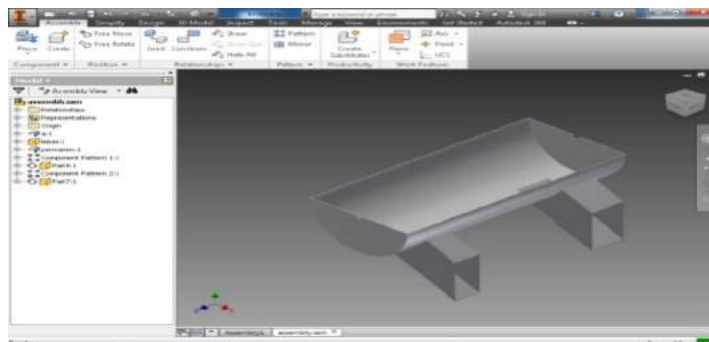


Figure 6. Assembly Lower Casing

(i) Axis Design

Click *new* then select *metric* then look for *standard* (mm) .ipt, then click *create* and select one of the axis of the *plane*, then create a circular *sketch* with a diameter of 25.4 mm according to the image, then click *extrude* with a distance of 1000 mm, then click one right side of the *new sketch*, continue to sketch with a diameter of 25 then click *finish sketch*, then click the *extrude* icon, then cut along 130 mm, after finishing *extrude* click the *thread menu* then click the *surface* with a diameter of 25 mm to make a thread. On the reverse side click on the surface then right-click *new sketch*, continue to make the sketch according to the image and then click *extrude* on the sketch that was created earlier, and click the *save icon* for the *file name*.

(j) Branch Chopper Knife Design

Click new select *metric* then look for standard (mm) .ipt, then click *create* and select one of the axis of the *plane*, then create a sketch with a diameter of 300 mm according to the image, then click the *extrude icon*, then select the 10 mm thick *extrude*, continue click the *new sketch* on the surface of the part then make the sketch according to the image then click the *extrude icon* select the cut on the field that was previously sketched, then click the *circular pattern icon* then click the *features* that were extrude then click the *circle side* and change *placement to 3* with 360 degrees then right-click on the surface of the *part* then click *new sketch*, make sketch with a diameter of 50 mm Then *extrude* as thick as 20 mm, then click the *filled icon* on the menu bar then click on the part that will make a radius according to the image, then right click on the surface then click new sketch, *continue* to make a circular sketch with a diameter of 25.4 mm, *extrude* cut on that field, and click *chamfer* on the bottom of the component that was previously made uat. Then click the edge on the edge of the part and give a distance of 5 mm, then click the *circular pattern icon*, then click on the *features* that were *extrude* and click the *side of the circle* and change the *placement to 3* with an angle of 360 degrees, then click *origin select xz plane* then visibility, then Click the *plane* on the menu bar then *drag the plane xz up along 25 mm*, then click *new sketch* on the work plane that was created then create a circle sketch according to the image, then extrude cut on the sketch circle until it translates according to the image, and click the thread icon to make the thread thread on the hole that was made, click the save icon with the name of the branch chopper knife.

(k) Leaf Chopper Knife Design

Click new select *metric* then look for *standard* (mm) .ipt, then click *create* and select one of the axis of the *plane*, then create a *sketch* with a length of 130 mm and a width of 30 mm according to the image then *finish sketch*, then click the *extrude icon* then select the field will be extruded 5 mm thick then click *ok*. Then click *chamfer*, then *chamfer* the edges of the knife with a *distance* of 2.5 mm then click *apply* and right click on the surface of the *part* then click *new sketch*, then create a *sketch* with a circle with a diameter of 8 mm according to the image, then click the *extrude icon* then cut on the *sketch* field that was created, and click on the *icon* with the *file name* leaf chopper knife.

(l) Circular Saw Design

For the circular saw design the steps - the steps for making the drawing are almost the same as the making of the knife chopper design drawings with different shapes and the number of 40 gear.

(m) Assembly Knife Component with Axis

Steps for making drawings Assembly of knife components with axis is almost the same as making assembly drawings on the upper casing components (like figure 7).



Figure 7. Assembly Knife with axis

(n) Assembly All Components

start clicking *new select metric* Then find the *standard* (mm) iam, then click *create*, then click *place* on the *menu bar* then click the component *file* that we want to *assemble* then click *open* and click *assembly display* then *ok*, then click the *constraint icon* select *join* menu, and *selection 1* shows on the width of the bearing, then click *selection 2* on the iron side U, then click *apply*, and open the *constraints* again, select the *join* menu, in *selection 1* click on the iron U field, the xyz axis will be locked, then click *apply*, then set the distance by measuring *distance*

assembly according to the image, and so on for the assembly steps of the other components and finally click the *save icon* with the file name *assembly component*, (like figure 8).

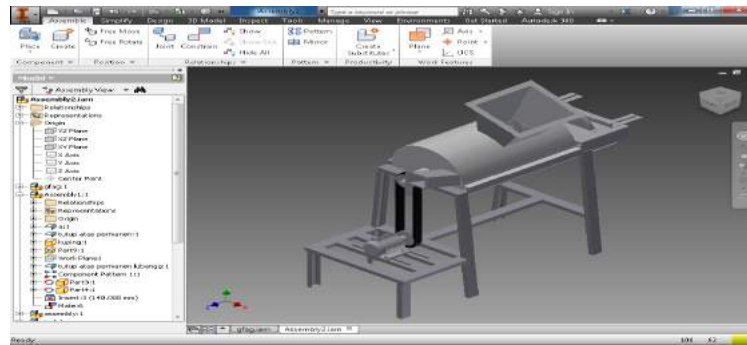


Figure 8. Assembly All Components

3.2 Working Drawing (Projection).

Working drawings are images that are used as a reference in the process of working on a product.

(a) The Making of Axis

In the process of making this transmission axis, using steel material ST 42 Ø 25.4 mm, (such as work Figure 9).

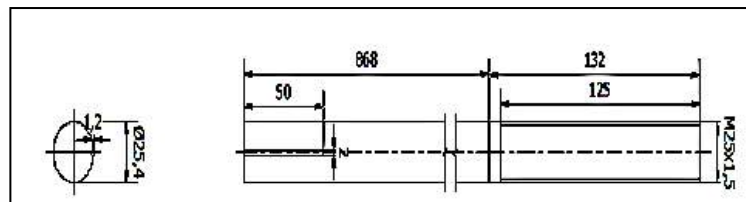


Figure 9. Axis

(b) The Making of Framework

Making frames using Iron Unp 50 mm x 32 mm x 23 mm, (like working Figure 10).

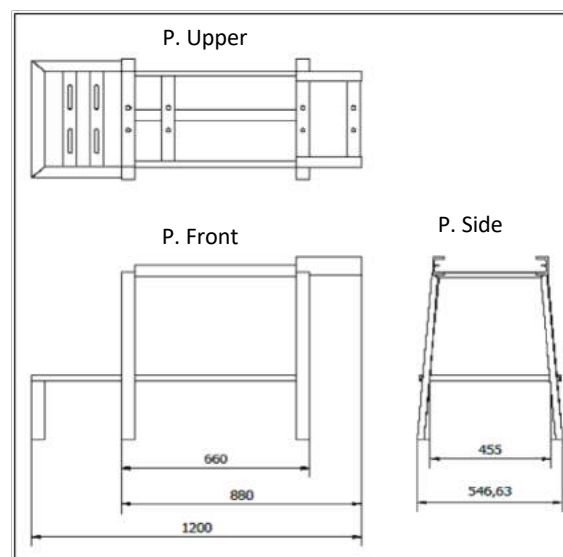


Figure 10. Frame

(c) The Making of Leaf Chopper Knife

In the process of making knives, cut the strip plate 40 mm x 32 mm with a length of 150 mm as many as 27 pieces, on the cut-off machine, (like image 11).

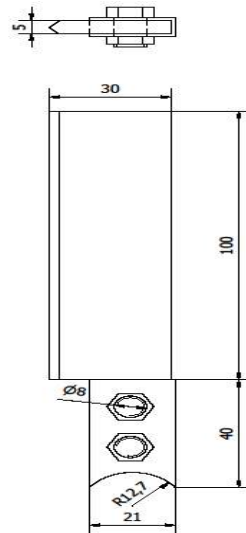


Figure 11. Leaf Chopper Knife

(d) The Making of Branch Cutter Knife

In the process of making this knife, using an 8 mm thick plate of eser cut with a length of 100 mm as many as 3 pieces, on the cut off machine with an angle of 450, (as shown in image 12)

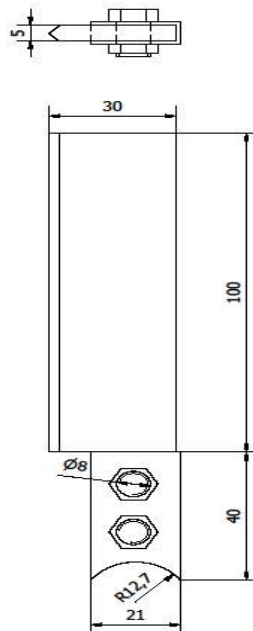


Figure 12. Branch cutter knife

(e) The Making of Casing

In the process of making this tube, cut the eser plate 2400 mm x 1200 mm x 2 mm with a length of 600 mm x 600 mm as many as 2 pieces, on hydraulic cutters, 1800 semicircular shapes, (as shown in Figure 13).

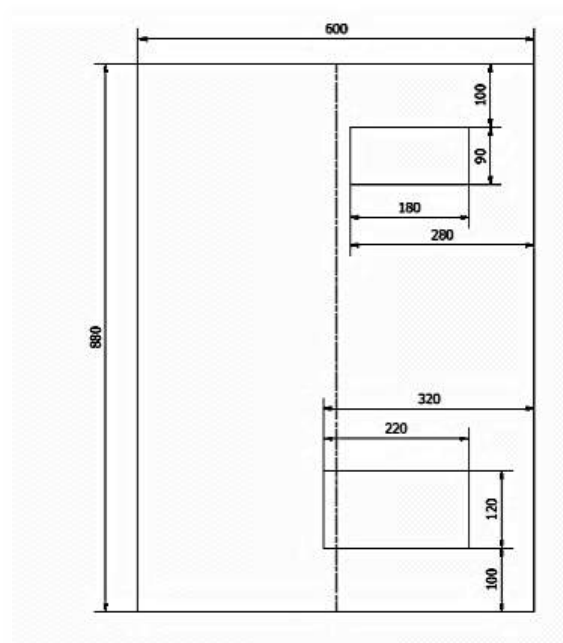


Figure 13. Casing

3.3 Plan Design Results

(a) Design Result Product

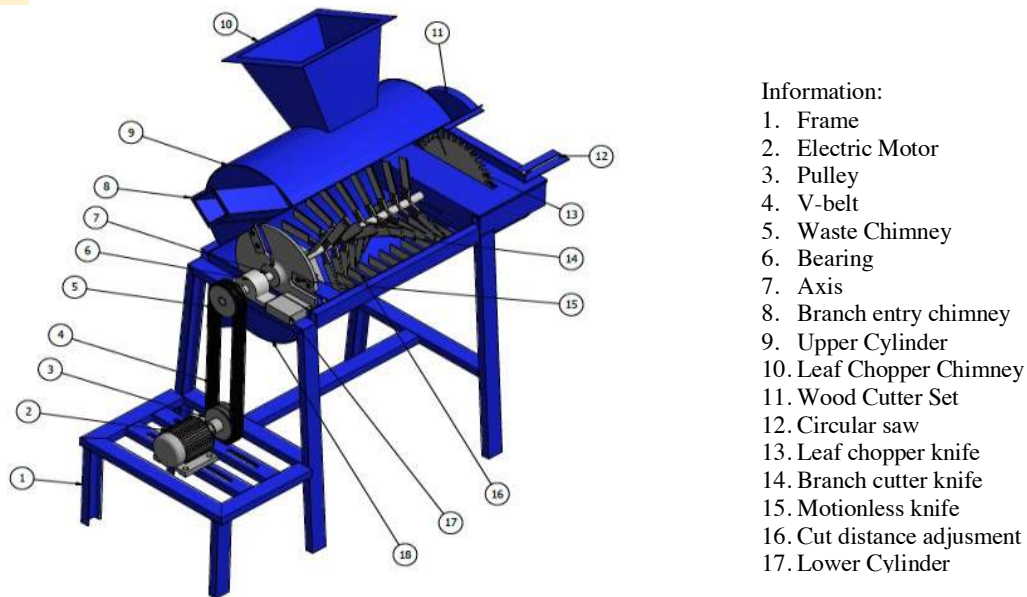
Based on the planned design construction as shown in Image 1, the results of designs and plans can be seen as shown in Figure 14, and 15 and its specifications.



Figure 14. Multifunctional Organic Waste Chopper Products

Specifications of Organic Waste Chopper:

Type Multi Function Waste Counter Machine 01, Capacity 50 kg / hour, Blade Type 10 fixed seeds, 27 seeds move 3 seeds, Circle Church 1 seed, 1 inch shaft, FrameUnp 5, Type V - A43 Belt, and V-Block Bearing UCP 6205.



Information:

1. Frame
2. Electric Motor
3. Pulley
4. V-belt
5. Waste Chimney
6. Bearing
7. Axis
8. Branch entry chimney
9. Upper Cylinder
10. Leaf Chopper Chimney
11. Wood Cutter Set
12. Circular saw
13. Leaf chopper knife
14. Branch cutter knife
15. Motionless knife
16. Cut distance adjustment
17. Lower Cylinder

Figure 15. Organic Waste Chopper Tool Design

4. CONCLUSION

4.1 Conclusionz

- a. Manufacture of organic waste chopper design, the first is a design idea, then the drawing process using the 2015 autodesk inventory program includes sketching, drawing components of machine parts, followed by assembly, then rendering and animation. The final stage of the design was included in the "IDW" complete with size, scale, material, work drawings making it easier for designers to make tools. With design drawings complete with working drawings (projections, scales and dimensions) can simplify the process of making tool parts and can reduce the risk of errors in the process of making tools.
- b. The design of the Organic Waste Chopper Tool using the Autodesk 2015 Inventor Software can simplify the process.
- c. Design specifications for Organic Waste Chopper tool are: Multi-Function Waste Counting Machine 01, Capacity 50 kg / hour, Blade type 10 fixed seeds, 27 seeds move 3 seeds, Circule Church 1 seed, 1 inch shaft, FrameUnp 5, Type V - A43 Belt, and V-Block Bearing UCP 6205.

4.2 Recommendation

In making the design, it is better to make the right size of equipment, especially between the hole and the shaft so that when the assembly process can blend easily. Each component size must take into consideration the ingredients on the market so that later in making the tools used the ingredients are easily available, and each component of the image must be as complete and clear as possible so that the reader is easy to understand.

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ANTI-THEFT PROTECTION OF VEHICLE USING GPS TRACKER & ANDROID APPS

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Abstract. The vehicle's anti-theft system is a module used to protect motor vehicles from theft by using three layers of security. The first layer uses a registered fingerprint for user authentication that can enable the machine on. The second one uses a GPS tracker to recognize where the position of the vehicle. The third one of security uses a remote engine cut-off system to shut down the machine remotely using the Android app. The system consists of two separate modules that are connected using a mobile data network. The first module is attached to the motorcycle body consists of fingerprints for biometric verification, GPS tracker for vehicle tracking and a microcontroller that controls the entire onboard system, including turning on and off the machine remotely. The second module is an application on the Android system used to detect where the location of the vehicle and applications that can be used to shut down the machine remotely. The method used in this research is the waterfall, it consists of systems and software design, module creation, module testing, module integration, system testing, operation and repair. The results shows this system is trusted to secure the motor vehicle by using a fingerprint as user authentication and GPS Tracker in which accurately detect the location of the motor vehicle, and then the system can shut down the motor power from a distance so that it can discover the theft of the vehicle. The conclusions: 1) The motorized vehicle safety system that is created to ease the owner of motor vehicle to control (On/Off) the vehicle remotely; 2) Si Kemot tool has been created to provide and increase the sense of security for vehicle owners because it can provide information on the position of the coordinates and speed of the vehicle; 3) the system can be controlled simply by using Android-based gadget that is very simple and ease of operation.

Keywords: UAV, network, fanet.

1. INTRODUCTION

Motor vehicles are not equipped with adequate security loophole theft crime. Key for activating the electrical system of a motor vehicle it is still not enough to give a sense of security because they can be activated using the other key. The location of the stolen motor vehicle can not be known by the owner [1,2].

Si Kemot (the Security System Motor) Integrated Fingerprint-Based GPS Tracker Android) is a breakthrough for the security measures of motor vehicles. The system is capable of providing security in a motor vehicle with a layered security system.



Figure 1 Architecture Design Systems Anti-Theft Vehicle Si Kemot

The system uses fingerprint as an interface to enable and disable the electrical system of a motor vehicle. Fingerprint is also equipped with an alarm that activates if an error occurs tap 3 times. In addition to a fingerprint is used also used a layered security system with Geofence as virtual fence system that activates an alarm if the motor vehicle out of the radius of the virtual fence and GPS tracker that can track the location using Android smartpone. GPS tracker can also be used to turn off the electrical motor vehicle engine remotely with the aid of a satellite connection [3,4].

2. METHODS

The problem is the background of the many cases of motorcycle theft due to the lack of security systems installed on motorized vehicles so that thieves can easily carry off motorized vehicles detected. So that an extra security system is needed to complement the standard security systems that already exist in motorized vehicles in general [5,6].

This study was literature research by reading books and browsing websites related to the physical structure Vehicle motor and electronic components that will be used for the manufacture of tools, and analyze the scientific journals that discuss Finger Print and GPS Tracker and android application so that it can be applied to create a security system motor vehicle with a finger print and GPS Tracker based on android.

Creating Si Kemot requires several component parts including GPS tracker module, fingerprint scanner, arduino uno board, android device, LED (light emitting diode), buzzer alarm, switch button, regulator, motor relay, 12 volt battery, chassis module.

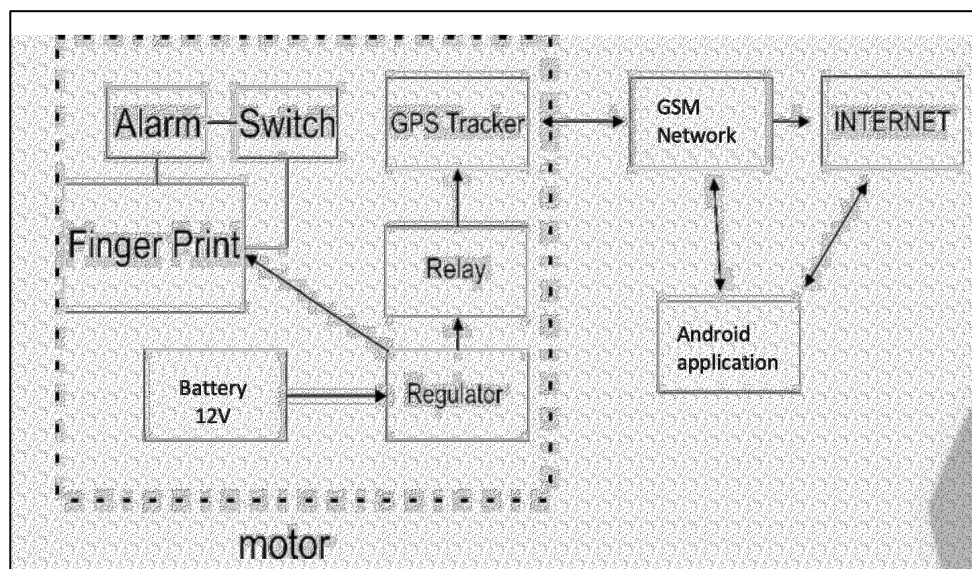


Figure 2. Block Diagram of the Motor Vehicle Safety Systems

3. RESULTS AND DISCUSSION

3.1 GPS Tracker Module

GPS (Global Positioning System) Tracker module is used to send the coordinates of the location of a motorized vehicle with the help of GSM components that have been integrated in it which then uses the GPRS signal to send location coordinates information with Internet aid [7]. Then, the information will be processed by an Android device that will be created. The GPS module is installed using resources from a 12 Volt battery that was previously installed by a regulator to reduce voltage. Next, to make a feature that can turn off the engine remotely, it is connected to the gas hose section. When the button on/off on Android is pressed it will automatically turn off the supply of electrical voltage to the engine so that the engine will shut down.

3.2 Fingerprint Scanner

The fingerprint scanner is used to enter fingerprint information from the user, then the information is processed on Arduino which is connected to the scanner. Information on scanner results in the form of fingerprint data can amount to more than one depending on input data when the program is created. So only registered fingerprints can activate the motor vehicle engine.

3.3 Arduino UNO board

The Arduino used is a type of uno that has qualified specifications for storing commands and fingerprint scanner data. Arduino will be used as the main component of data processing and system commands that will be assembled into a kit with fingerprint and alarm. Arduino power supply will be received from a 12 volt battery that was previously installed by the regulator as a component to ensure more stable voltage.

3.4 Android devices

Android devices used are Samsung's smartphone operating system J7 with Marshmallow for applications made to have a minimum specification of the OS so that applications can run smoothly. Android devices are used to monitor the location where the vehicle mounted GPS is located. Android app created has a feature location tracking and deadly from a distance. The tracking feature would have to see the maps then turn off the feature remotely described as a push button on/off.

The Android device used is a Samsung J7 smartphone with the *Marshmallow* operating system because the application created has the minimum OS specifications so that the application can run smoothly. An android device is used to monitor the location where a GPS-installed vehicle is located. The android application created has a location tracking feature and also shut down remotely. The tracking feature will have a map display then the remote shutdown feature is described as a push button on/off.

3.5 LED (Light Emiting Diode)

The LED is used as a fingerprint scan indicator successfully or not. The LED lamp is green if the fingerprint is scanned according to previously stored data, while the LED lights are red if the scanned fingerprint does not match the stored data. LED lights are installed in the kit package.

3.6 Buzzer Alarm

Alarm buzzer is used as a warning if there is an error when scanning fingerprints 3 times. The alarm will alert the motor vehicle owner that the motor vehicle is in a danger state. Buzzer alarm is installed in the kit package.

3.7 Switch Button

The switch button is used for emergencies when the owner's fingerprint cannot be used due to injury, wet or dirty. This switch is installed in the hidden neck of the motor. This button will manually turn on the electric motor after the motor lock is on.

3.8 Regulator

Regulators are used to stabilize the voltage that enters the component to make it safer because the input voltage on the vulnerable component is unstable. The regulator will be connected directly to the GPS and fingerprint kit package.

3.9 Relay motor

Motor relays are used to cut off electricity or connect electricity. This is to support the remote shutdown feature using the help of a GPS tracker.

3.10 12 Volt Battery

12 Volt battery/accu is used as the primary power source to activate each component in order to work properly. The battery will be connected to any component of the position in accordance with the block diagram.

3.11 Casing Module

Components finger print, alarm, LED and will be assembled into a package arduino kit with chassis modules. In addition to giving the efficiency where it also serves to protect the component from unwanted interference.



(a)

(b)

Figure 3 Results hardware design (a) and anti-theft device (b).

3.12 The Working of the System

The result shows that the security system available on motor vehicles is less powerful, this causes many motor vehicle theft, therefore, the *Kemot* can be used as a supplementary motor security system to detect where the motor vehicle is.

The use of fingerprint in the *Si Kemot* device circuit is combined with the Arduino Uno module. Finger print installed on the motor as the first level of security is user authentication with Arduino Uno as a microcontroller program that will detect the thief whether it is allowed to use motorized vehicles or not. If user authentication is successful, the motorized vehicle will turn on by itself. However, if user authentication is not successful the motorized vehicle will not turn on and wait for further authentication to turn on the motor vehicle.

At the time of assembly of the Construction Design Tool there are several obstacles that android application inadequate thereby making Geofence system and VoIP (Voice Over Internet Protocol) can not be applied. As a result of Geofence system that does not work then the alarm that should serve as a warning of a danger are transferred to the system cut off the GPS Tracker.

Si Kemot was made into two parts, the first is the security section in the form of a fingerprint scanner or Fingerprint programmed with Arduino Uno which functions first to activate the engine, only registered fingerprints can activate it. Then the second part is a GPS Tracker system that serves to track the location of the vehicle and can also be used to shut down the engine remotely.

GPS Tracker can find out the existence of motorized vehicles based on google map coordinates with an accuracy of 5-10 meters. These coordinates will continue to be updated by internet signals that are already connected to the GPS. The scattered coordinates can be recognized through the Orange Application or the user will get an SMS from the GPS. The following is a description of the coordinates displayed on the Orange Application.



Figure 4 Tracking the position and speed of vehicles

There are several coordinates that appear, with a record of the time, date and speed of the motorized vehicle. This is because when the vehicle moves, the GPS will detect and the signal from the GPS will be sent via an internet signal to the user. GPS Tracker can find out the existence of motorized vehicles based on google map coordinates with an accuracy of 5-10 meters. These coordinates will continue to be updated by internet signals that are already connected to the GPS. The scattered coordinates can be recognized through the Orange Application or the user will get an SMS from the GPS. The following is a description of the coordinates displayed on the Orange Application

Furthermore, if we do not recognize the detected coordinates or we read that our motorized vehicle has been stolen, we can cut off the electricity of the motorized vehicle with the cutoff switch installed. But the electricity of motorized vehicles can be turned off if the motorized vehicle is not moving or stopping.

From the results of the Construction Design Making Tool above, *Si Kemot* can still be used but there are several differences in system work with the existence of an Android Application that has not been achieved. The initial attempt to cover up this weakness was to shift the role of the Alarm which should be the initial detector of a danger to a cut off system on the GPS Tracker. Development is still ongoing to improve the effectiveness of this tool. This tool has great potential in everyday life.

4. CONCLUSION

It can be concluded that:

1. The motorized vehicle safety system that is created to ease the owner of motor vehicle to control (On/Off) the vehicle remotely.
2. *Si Kemot* tool has been created to provide and increase the sense of security for vehicle owners because they can provide information on the position of the coordinates and speed of the vehicle.
3. The system can be controlled simply by using an Android-based gadget so that it is very simple and easy to operate.

5. ACKNOWLEDGEMENT

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THE IMPLEMENTATION OF RECTIFIER TECHNOLOGY FOR SMALL SCALE INDUSTRIES PRODUCING EXHAUST PIPE IN PURBALINGGA

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Purbalingga Regency Government policy to include exhaust pipe as one of the region's leading commodities is considered as one finest step. Various types of motor vehicle are produced and as a result small industry engaged in motor vehicle spare parts are emerging, including exhaust parts. The choice of technology with the metal industry, especially the exhaust in Purbalingga aims to improve the competitiveness of regional superior competency-based industries, namely revitalizing the industrial sector in order to exist and be able to develop, and be able to transfer technology about improving exhaust quality which has an impact on increasing the exhaust industry's income. The exhaust products from SMEs have exclusivity in the tip of exhaust pipe that is coated with metal, thus improve the appearance and quality of the exhaust. But the exhaust product with a variety of metal coated parts turned out to be incompatible with industry standards, which consequently the quality of the results of the dull metal coating process, easy to peel and rusty. For this reason, Semarang State Polytechnic implements rectifier equipment for metal coating. The methods used were the founding of an Institution Forum for the Purbalingga Exhaust Cluster Association, metal coating technique training for workers, operating tests, operational procedures and operational assistance. The results obtained are rectifiers for metal coating with current outputs of 10 A, 20 A, 30 A, 40 A, 50 A.

Keywords : rectifier, metal coating, exhaust.

1. INTRODUCTION

Purbalingga Regency has a set of three superior commodity areas to develop, namely exhaust, batik, and artificial hair. The policy of this regency to include exhaust as one leading commodity is considered as one of its finest movement.

Various types of motor vehicle products are produced so that small industries engaged in motor vehicle spare parts, including exhaust parts, are emerging. The choice of technology with the metal industry, especially exhaust in Purbalingga aims to improve the competitiveness of regional superior competency-based industries, namely revitalizing the industrial sector in order to exist and be able to develop, and be able to transfer technology on improving exhaust quality which has an impact on increasing exhaust industry's income. Besides that, small exhaust industry cluster in Purbalingga has become industrial partner of Semarang State Polytechnic in collaboration with Purbalingga Government in terms of technology in the process of nickel plating, chrome plating, hand plating, anodizing, metal welding, electroplating waste treatment. Small and medium industries which are one of the mainstay industries and mostly in industrial centers in the villages of Purbalingga Lor, Kembaran Kulon and Kalimanah, Mrebet, Wirasana, Bojongsari and Padamara are small metal industries, especially exhausts which have an exclusive design on the exhaust gas pipe end casings. The number of business units is 148 business units with employment of 658 people and total production of 67,719 pieces / month and

production value of Rp.3,344,751,000 / month. The distribution area of the small industrial exhaust Purbalingga Lor has 87 business units, Kembaran Kulon 32 business units and the Kalimanah, Mrebet, Wirasana, Bojongsari and Padamara regions as many as 29 business units. In Purbalingga district there are 2 (two) SMEs (Small and Medium Enterprises) exhaust which have the potential to move in the field of electroplating and anodizing and the manufacture of exhaust caps, namely UKM Dwi Karya Mandiri and UKM Nirwana Knalpot. The exhaust products from SMEs have the exclusivity of the electroplating or colored anodizing process, which adds to the appearance and quality of the exhaust [1] [2]. But the exhaust product with variations in the electroplating and anodizing parts turned out to be incompatible with the industry standard SNI.09-0425-1999, which consequently the quality of the dull electroplating process, easy to peel and the color of the end pipe exhaust gas easily wear off. Besides that, the quality of the exhaust cap is bumpy, not symmetry, because it is done only using a hammer not using dies and mattresses [3] [4]. For the marketing aspect, it is still done traditionally by waiting for orders from various automotive industries which require exhaust as one of the vital automotive components.

Purbalingga Regency is divided into 18 Subdistricts with an area of 77,764,122 ha which has the potential of small and medium industries in 2010 as many as 21,891 business units consisting of various types of businesses and can absorb as many as 75,259 people. However, this business has not shown encouraging results, as evidenced by this sector, which until 2010 was only able to contribute 8.04% to the GRDP of Purbalingga Regency at constant prices. (BPS, 2014)

The pattern of working relationships among prospective partners is that each SME has several differences that lie in the type of product, the type of marketing agent, and the consumer segment. In terms of product, UKM Karya Karya dominantly produces exhaust from various materials with rainbow color designs and motifs, while UKM Nirwana Knalpot produces exhaust for two-wheeled motorcycles with chrome plating. In general, the pattern of employment relations between SMEs is very good, this is seen, for example, among SMEs, often borrowing from various materials and equipment. For example, when the UKM Dwi Karya Mandiri lacked material, the UKM Nirwana Knalpot would supply and vice versa or other materials. Likewise in terms of equipment and design among SMEs, they will complement each other, especially the exhaust of two-wheeled vehicles, because to make one type of exhaust equipped with rainbow colors requires electroplating equipment, usually requiring precision cutting machines.

The main problem in the electroplating process is that the production process still uses conventional (traditional) equipment and the results is not in accordance with industry standards, so the quality of the products produced is still low and exhaust coating products are easy to peel off and dull

2. METHODS

This Science and Technology activity for Regional Leading was carried out between Semarang State Polytechnic Service Team and SMEs partner in 2018. The problem solving activities from Semarang State Polytechnic to partners were carried out in stages. The lecturer team involved was 4 lecturers in accordance with their expertise and 10 students who helped solving the SME problem. Details are shown in figure 1.

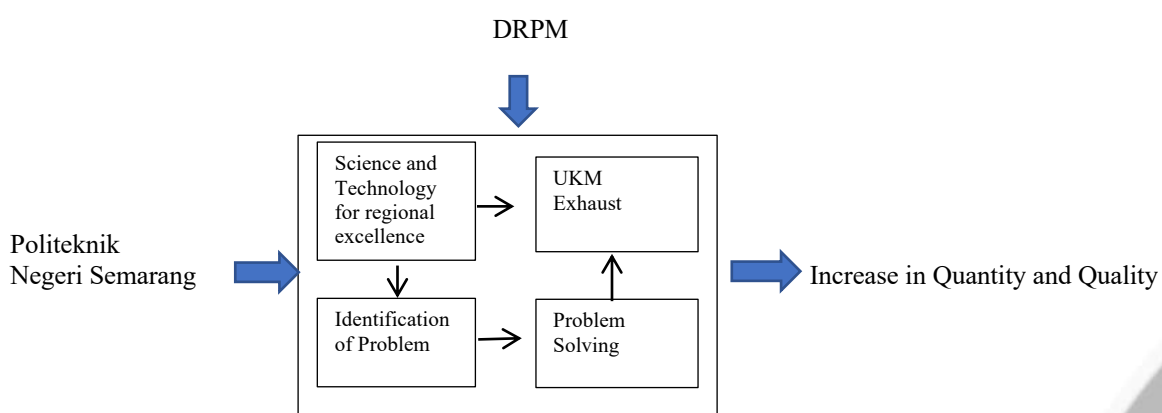


Figure 1 Scheme to solve problems in exhaust industry

Table 1 shows the patterns and methods of implementing science and technology for local superior products

Table 1 Patterns and Methods of Science and Technology Implementation for Local Superior Products

The Implementation of Science and Technplogy	Implementation Phase
The making of this electroplating tool is to solve the problem of small exhaust industry that does not have this equipment unit whose production process is given to other industries or the small industrial exhaust time that receives electroplating services but its production equipment does not meet the electroplating copper, nickel, chrome and exhaust standards.	<p>Tool planning Calculation of maximum capability in the power supply for copper, nickel and chrome coating can be adjusted by 10 A, 20 A, 30 A, 40 A, 50 A.</p> <p>Framework Planning and Calculation</p> <p>The electroplating frame is used to place the plating tub and electrode, place the control board and to put the power supply. The frame of this electroplating device is made of iron profile L with a size of 50 x 50 mm.</p>

Partner Participation in Program Implementation with Science and Technology Implementation Team for Local Superior Product:

- Establishment of the Institution Forum for the Purbalingga Exhaust Cluster Association or Joint Cluster Business Group
- Setting the layout (production flow) in total starting from cutting, forming, rolling, electroplating process to the packaging process.
- Participate in anodizing techniques
- Participate in training in metal coating techniques (electroplating)

Evaluation of Program Implementation and Program Continuity

Science and Technology Implementation Activities for Leading exhaust industry clusters will open opportunities to further enhance the effectiveness of cooperation with external partners, especially local governments so that external networks can be well developed. The results of the science and technology implementation activities for the superior area of the exhaust industry cluster can also be utilized for the sustainability of the community service program with the direction of developing the competencies of partners, industry and local governments, so that the sustainability of the program can run. Especially for the motor vehicle accessories industry, exhaust has begun in 2006 in collaboration with the Polines, especially in terms of welding, coating, material and energy use. Evaluation of program implementation is carried out annually by the Polines internal monitoring and evaluation team and the external DRPM team that evaluates the achievements and outcomes of the Regional Superior Science and Technology Implementation program per year.

Facilities available at Higher Education

The facilities for infrastructure or laboratory equipment and workshops related to the activities of the Science and Technology Implementation Program for Regional Leading owned by Semarang State Polytechnic are shown in figure 2:



Figure 2 *electroplating device*

3. RESULTS AND DISCUSSION

The solutions offered and the target outcomes are shown in table 2 below

Table 2. Output target

Business Aspect	Solution	Output
Production	<ul style="list-style-type: none"> ▪ Metal coating techniques, metal coloring techniques, metal coating tubs.[5]. ▪ Shiny, smooth, flat exhaust coating products, not easy to peel or shatter.[6] [7]. 	<ul style="list-style-type: none"> • The development of metal coating and metal refining techniques in accordance with industry regulations, not easy to peel, not shatter, shiny, flat, to make power supply [8].

The main rectifier circuit is a transformer, rectifier, load current regulator.[9] [10] [11] [12] [13]. Figure 3 below is a block diagram of a rectifier

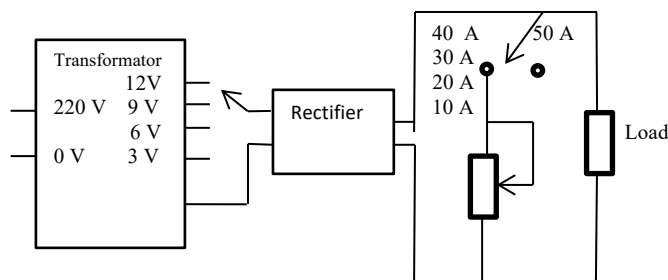


Figure 3 Block diagram rectifier

Figure 4 below is the transformer used for the rectifier

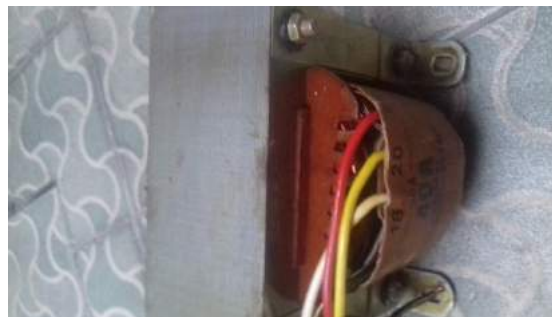


Figure 4. Transformer for rectifier

Figure 5 below is a rectifier circuit



Figure 5. Rectifier circuit

Figure 6 below is a rectifier in a laboratory



Figure 6 Rectifier in the laboratory

Figure 7 below is an electroplating tub that exists today



Figure 7 The current electroplating bath

Figure 8 below shows the electroplating bath that was made



Figure 8 Electroplating tubs made

Figure 9 below shows the finished exhaust



Figuri 9 the finished exhaust

Figure 10 below shows the exhaust that will be sent



Figure 10 Exhaust to be sent

How to use a rectifier for electroplating:

1. The exhaust that will be carried out by the electroplating process is included in the electroplating bath.
2. The positive end (anode) of the rectifier is connected to the material for the coating, the negative end (cathode) is connected to the material to be coated.
3. Put the current position according to the needs.
4. For a current of 50 A, there is no setting, the switch is immediately placed in position 50 A.
5. For other currents after being placed in the appropriate position, it is necessary to adjust the obstacles so that the current flowing is as needed.
6. For the voltage placed the voltage position according to the needs.
7. This rectifier uses an input voltage of 220 V. after being connected to a socket, the switch is turned on.

Thus a brief review of how to operate a rectifier for electroplating. Understanding the operation of rectifiers is very important to keep the rectifiers used to work optimally. In addition to avoiding fatal damage due to a faulty procedure using the rectifier. Hopefully this brief explanation can be useful for rectifier users.

4. CONCLUSION

The results obtained are rectifier for electroplating, power capability of 600 W with input voltage 220 V, output voltage 3 V, 6 V, 9 V, 12V and current 10 A, 20 A, 30 A, 40 A, 50 A. In order for the operation and use of the rectifier tool to have optimal results, it needs training for partner members as well as empowering the community to know about the operation of the rectifier equipment.

5. ACKNOWLEDGEMENT

We would like to express our gratitude to the Directorate of Research and Community Service; Local Superior Science and Technology Program 2018

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IMPLEMENTATION OF PUMP INSTALLATION SIMULATION WITH SMART RELAY BASED WATER LEVEL FOR PRACTICAL TOOLS IN LEARNING PROCESS

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Abstract. Polytechnic is a skill-based education with a lot of training and practice, it is necessary to be prepared a practicum facilities in terms of instrumentation and control devices, especially pump installation system. An important role in the operation of a system is the electrical system in the form of control is useful to facilitate pump installation operation system and this piping is called the Water Level Control. The complicated difficulty of assembling electrical installations manually. This problem can be solved with water level control pump installation system based on smart relay. The purpose of this research is to know the discharge of pump water. The data show the average of the water debit calculation theoretically 1.03 liters / minute, mean water debit test at 1.44 liter / minute tool. In conclusion there is a difference about 0.41 liters / minute, the determination of frictional factor price, coefficient of endurance, pipe diameter, bend type in the specification material not in accordance with the actual material size. It is suggested to the policy makers in the field of vocational education that the tools and practical facilities must be well designed to more effectively consider the condition of student learning.

Keywords : Pump installation, smart relay, water level control.

1. INTRODUCTION

Today the international climate leads to industrialization and requires much alumni of the Mechanical Engineering Department who has good qualifications. Polytechnic is education based on skills with debriefing which is quite a lot in the field of practice. The Mechanical Engineering Department will also strive to improve the competence of graduates by providing knowledge that enables graduates to compete in the industrial world.

Increasing the competency of graduates is very necessary to prepare practical facilities in terms of instrumentation and control equipment, especially those related to the pump installation system, this system is widely used in hotels, offices, households and industries. This fluid channel installation system plays an important role in the process of fluid distribution and the efficiency of a fluid channel will be maximal [1].

The things that need to be known in understanding the fluid channel installation system are the plans made appropriately include; determination of pump capacity, pump head, pump power, fluid flow discharge, pipe diameter, pipe position, fittings and bends [2], in addition to those often found in tanks or reservoirs that support system performance especially the system clean water. Reflecting the pump installation system that is no less important and has an important role in the operation of a system is a useful electrical control system to simplify the process of operating a pump installation system and piping is called Water Level Control [3].

The electrical system can be adjusted according to user needs. The electrical system is in the form of controls, there are some difficulties including, complicated in assembling manual electrical installations. This fluid channel installation system includes pumping systems, piping systems, and electrical systems that are still lacking

in understanding the basics of the system.

This problem can be overcome by using a smart relay-based water level control system for the learning process. The smart relay system can work automatically, the cost is cheap, maintenance is low, and is quite good when applied in the workplace [4]. It is hoped that this system can improve the competence of the practitioner and graduates can compete in the world of work.

Starting from the description above that focuses on research on pump installation simulation tools with smart relay based water level control, the problem formulation can be described as follows: (a) how to design a pump installation simulation tool with smart relay-based water level control? (b) can the installation of pumps with water level control based on smart relays be used to test the water discharge (Q) of the pump?

The purpose of simulating pump installations with smart relay based water level control in this study is as follows: (a) know the basics of designing pump installation simulations with water level control based on smart relays, (b) Knowing the pump installation simulation with water level control based smart relay as a practical tool for pipe, pump and electricity installation with water level control and smart relay, and water discharge (Q) from the pump, (c) the output target of this research is the basic understanding that occurs in the system. This simulation will be a method that makes it easy to design piping and control installation systems and engineering applications. The results of this study are published in the PNB logic journal.

The benefits of simulating pump installations with smart relay based water level control in this study are as follows: (a) useful as a practical tool about pumping systems, piping and electricity on water pipe installation, (b) useful as a tool to increase competence in the learning and progress process Bali State Polytechnic Mechanical Engineering Department, (c) useful as a tool to complete the learning facilities in the practicum of the Engineering Department Bali State Polytechnic Machine, so that students master the pumping system, piping and electricity especially with water level control based on smart relay.

2. METHODS

2.1 Design Concepts

The design concept carried out in this study was to design a clean water installation which is usually used as a pump installation simulation device with smart relay based water level control, which was used as a practice simulation for students in the Bali State Polytechnic Mechanical Engineering Department. Design drawing Pump installation simulation tool with smart relay based water level control [4], installation design can be seen in Figure 1.



Figure 1 Simulation of the Pump System

2.2 Scope of Research

The scope of research in making pump simulation devices with smart relay based water level control is as follows:

- Drawing and location of components on pump simulation devices with water level control based on smart relays, for installation of clean water.
- Installing the components in the piping installation on the work desk.
- Looking for data, namely pump water discharge in a simulation tool.

2.3 Location of Application Simulation Tools

The application of a pump installation simulation tool with a water level control based on smart relay is applied as a practical simulation tool in the Laboratory of Mechanical Engineering of the Bali State Polytechnic.

2.4 Instruments and Materials

The instruments and materials used in this study are as follows:

a. Measuring instruments used

- 1) Stop watch is used to record the time to calculate debit (l / sec).
- 2) Metal meters are used to measure the height, length, width of the work table.
- 3) Digital cameras made by Japang are used to document every activity inside this research.

b. Material used

The materials used in this study were one work desk unit, four pump units with a capacity of 10 l / minute, a 3 liter water tank, a PVC pipe (poly vinilchloride) of ½ "size, 3 water level control, smart relay.

2.5 Data Collection

The data collected from the pump installation simulation tool with smart water level control based on the other is the pump water discharge. Data obtained from the pump installation simulation tool with smart relay based water level control is used to determine the water discharge (Q), and be labeled.

2.6 Research Procedures

To avoid errors in data collection, a research procedure is made as follows:

a. Preparation stage

- 1) Library study
- 2) Take care of the letters needed to support the course of the research.
- 3) Establish a place of research
- 4) Ask permission from the head of the Mechanical Technology Workshop to conduct research.
- 5) Prepare data collection officers and tools for research purposes.

b. Implementation Phase

- 1) Determining the dimensions of the material used
- 2) Measurements refer to the simulation system in the pump simulation system.
- 3) Record data obtained and labeled.
- 4) Comparing the average water debit calculation theoretically with the average water discharge data from testing

2.7 Data Analysis

Data obtained from the results of measurements or calculations from two treatments are analyzed, with the aim to find out how much difference occurs or there is no difference between the ait debit data in theoretical calculations with the water discharge data from the test on the pump simulation tool.

3. RESULTS AND DISCUSSION

3.1 The way the Pump System Works

The workings of the pump system simulation tool with water level control based on smart relay are divided into two parts, namely:

a. How to work part one of the pump system

How it works pump part one is pump 1 functions to suck water from the tube 1 then pump water into the tube 2. Pump 1 works according to the command of water level control 1 which will signal pump 1 to live or die according to the amount of water in the tube 2. Next pump 2 functions to suck water from tube 2 then pump water to tube 4. Pump 2 works according to the command of water level control 2 which will signal pump 2 to live or die according to the amount of water in tube 4, shown in figure 2.

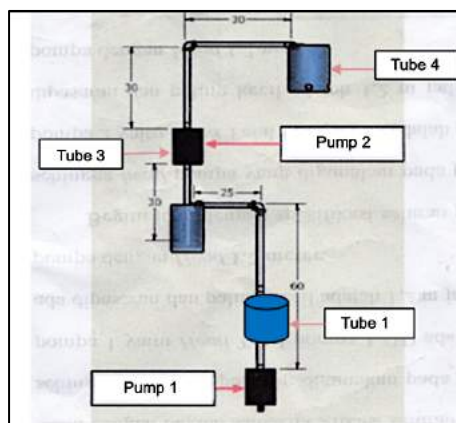


Figure 2 How the pump system works

b. How to work part two of the pump system

The way it works is pump 4 functions to suck water from tube 1 then pump water towards tube 3. Pump 4 works according to the order of water level control 3 which will signal 4 pump live or die according to the amount of water in the tube 3. Then pump 3 functions to suck water from tube 3 then pump water to the tube 4. Pump 3 works according to the order of water level control 4 which will give the signal to pump 3 live or die according to the amount of water in tube 4, shown in figure 3.

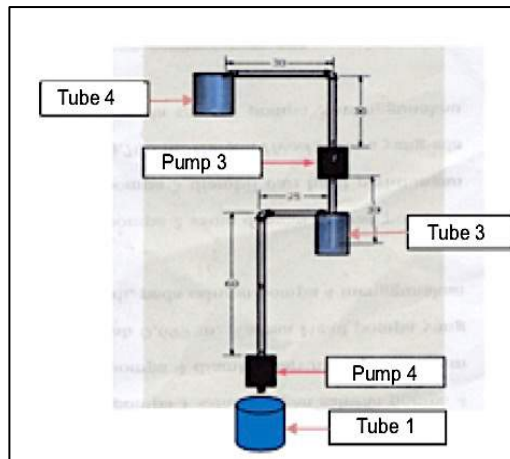


Figure 3. How the Pump System Works Two

In practice, only pump 2, between pump 1 and pump 2 (including part one pump system), while pump 4 and pump 3 (including part two pumping system), if part one of the pumping system works then part two of the pumping system does not work otherwise alternately. But when the POWER + button is pressed then part one and part two of the pump system works, this is done at any time if the water needs are not sufficient, then all pump systems need to work to meet the water needs of the water installation system.

3.2 Calculating theoretical water discharge (Q)

By knowing the results of calculations and data that exist in the installation of pumps with water level control based on smart relays as follows:

Pipe diameter (D) = 0,0166 m

The acceleration of the flow in the pipe = 0,471 m/s

calculate the pipe area and Q [5,6] as follows:

$$\text{Pipe area} = \frac{1}{4} \cdot \pi \cdot D^2 \dots\dots\dots (1)$$

$$= \frac{1}{4} \cdot 3,14 \times 0,000276 \text{ m}^2$$

$$= 0,000217 \text{ m}^2$$

$$Q = A \cdot v \dots\dots\dots (2)$$

$$= 0,000217 \text{ m}^2 \cdot 0,471 \text{ m/s}$$

$$= 0,000011 \text{ m}^3/\text{s}$$

$$= 1,03 \text{ liter/minute}$$

So the water discharge (Q) on one tap is 1.03 liters / minute

3.3 Data on Test Results in the Pump Installation System

Data of water discharge from the results of theoretical calculations and test data from the pump installation system with smart relay based water level control, are shown in Table 1.

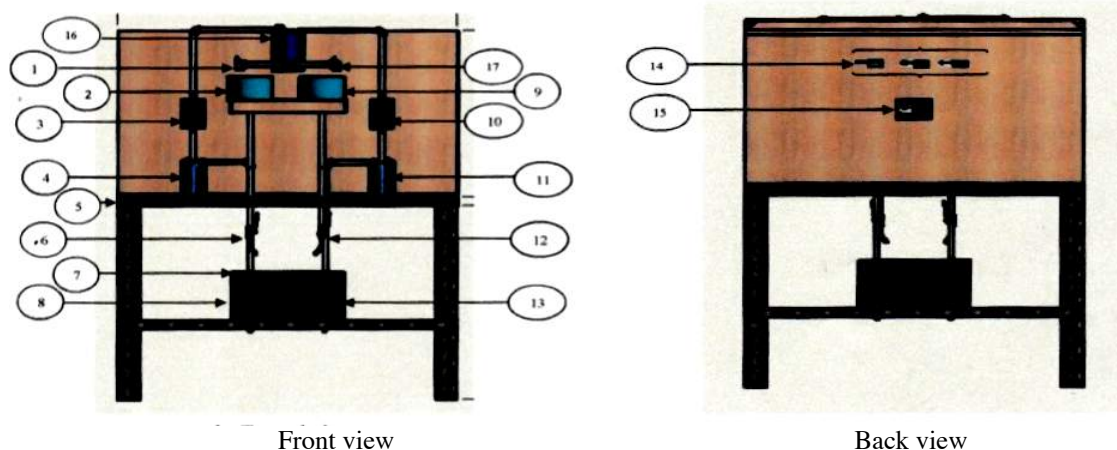
Table 1. Water Discharge from Two Passages

Data Number	Theoretical Calculation Results (liter/minute)	Tool Testing Results (liter/minute)	Different (liter/minute)
1	1,03	1,75	0,72
2	1,03	1,65	0,62
3	1,03	1,55	0,52
4	1,03	1,45	0,42
5	1,03	1,35	0,32
6	1,03	1,25	0,22
7	1,03	1,15	0,02
8	1,03	1,10	0,07
9	1,03	1,09	0,06
10	1,03	1,05	0,02
11	1,03	1,05	0,02
Average	1,03	1,44	0,41

In table 3.1 shows the average water discharge calculated is 1.03 liters / minute while the average water discharge test results on the tool is 1.44 liters / minute, this means there is a difference of 0.41 liters / minute, this because in determining the price of friction factor and resistance coefficient, pipe diameter and type of bend in the material specifications do not match the size of the material actually [2,7].

3.4 Pump Installation Simulation with Water Level Based Smart Relay for Practicum in the Learning Process

Pump Installation Simulation with Water Level Based Smart Relay for Practicum in the Learning Process as Figur 4 follows:



Information:

- | | |
|-----------------|--------------------------------------|
| 1. Tap 1 | 10. Pump 3 |
| 2. Tube 3 | 11. Tube 3 |
| 3. Pump 2 | 12. Stop the tap 2 |
| 4. Tube 2 | 13. Pump 4 |
| 5. Workbench | 14. Water Level Control (1,2, dan 3) |
| 6. Stop the tap | 15. Smart Relay |
| 7. Tube 1 | 16. Tube 4 |
| 8. Pump 1 | 17. Tap 2 |
| 9. Tube 3 | |

Figur 4. Pump Installation Simulation

4. CONCLUSION

4.1 Conclusions

From data collection on a pump simulation tool with water level control based on smart relay, conclusions can be drawn as follows:

- a. Pump simulation tool with smart water level control based on being able to as a practical tool to test water discharge, and able to improve in the learning process
- b. Showing the average water debit from the theoretical calculation is 1.03 liters/minute, while the average water discharge from the test results is 1.44 liters/minute, this means that there is a difference of 0.41 liters/minute, this is because in determining the price of the friction factor and the coefficient of resistance, the pipe diameter and type of bend in the material specification do not match the actual material size.

4.2 Suggestions

- a. To policy makers in the field of vocational education in order to provide practical and practical facilities to more effectively pay attention to the conditions of student learning.
- b. Further researchers can do more accurate data retrieval by measuring the material directly actually do not depend on the specifications in the material, thus it will be obtained more accurate results.

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1-DOF FINGER MECHANISM DESIGN FOR ANTHROPOMORPHIC PROSTHETIC HAND WITH SIMILARITY CRITERIA FOR HUMAN HAND FINGER MOVEMENT

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Abstract. Development of prosthetic hands continues to be made to get prosthetic which has special characteristics, namely anthropomorphism. The anthropomorphic prosthetic design refers to the improvement and development of the design to the stage of the similarity of the prosthetic movement to human hand movements. This study carries the design of the anthropomorphic 1-DOF prosthetic finger mechanism to get prosthetic at an affordable price. The optimization criteria for the similarity of movement with the human hand are formulated with two objective functions, namely the similarity of the range of motion and the total length of the finger that is completed simultaneously. The human hand movement that is a reference is the movement of conical object grasping on a standard size conical according to the maximum hand-held diameter anthropometry of an Indonesian people.

Keywords : Prosthetic Hand, Anthropomorphic, Range of Motion.

1. INTRODUCTION

Prosthetic hands that can replace the function of human hands are said to fulfill the anthropomorphic aspect. Until now several studies have been conducted to produce prosthetic anthropomorphic fingers. Banks [1]-[3], developed a design and control system on anthropomorphic finger equipped with touch sensors. Zollo et al. [4], describes research on anthropomorphic prosthetic design through a biomechatronic approach. Kurita et al. [5], developed an anthropomorphic hand with a driving mechanism on the arm and the force transmitted to the hand through the gear on the wrist. Jaffar et al. [6], designed anthropomorphic hands that can perform grasping movements for varying object sizes. Azlan and Yamaura [7], optimize parameters in the design of anthropomorphic fingers to perform movements in the form of grasping and pinching.

Most of these studies produce expensive designs because of the complex control mechanisms. The Laboratory of Robotics and Mechatronics (LARM), Italy, developed a system of low-cost easy operation in robotic hand designs, named LARM Hand [8] LARM Hand is an anthropomorphic finger design developed by the Robotics and Mechatronics Laboratory, Cassino, Italy. LARM Hand is designed from materials that are cheap and not too heavy, namely aluminum alloys with a 1-DOF movement [9]. Construction of LARM Hand 4 consists of three fingers with each finger having three phalanx and composed of 5 links. The motion mechanism used in the LARM Hand is a cross-four bar link with the press system or push on the link at the base of the finger. The design of the connecting link on the LARM Hand is inside the main link (phalanx) so that the design of the anthropomorphic hand in terms of its shape can be achieved.

The design form of LARM Hand gives hope for Indonesian to develop a functional prosthetic hand at a price that is affordable for the people of Indonesia. The design of the anthropomorphic fingers on the LARM Hand uses a driving mechanism in the form of a push or push system on the base link, which then moves the middle and end segments.

This study aims to create a finger mechanism with anthropomorphic aspects by considering the LARM Hand mechanism. The design of anthropomorphic fingers in this study uses a 1-DOF low-cost easy operation system and has a drive system at the base of the finger in the form of a pull to prevent buckling. In addition, there is no standard for the position of grasping objects in previous studies. This study proposes the standard size of objects that are in accordance with the maximum hand-held anthropometric data of the Indonesian people. This is closely related to the use of prosthetic anthropomorphic fingers for industrial work requirements and the user's daily activities.

2. METHODS

The method used is to build the linkage which support the prosthetic hand mechanism to move naturally like human fingers. The data collected are the anthropometric measurements of the human hands. The anthropometric measurements of human hands were carried out on 60 respondents with details of 30 men and 30 women in the productive age range of 20 to 60 years. Anthropometric data taken is represented by 25 dimensional classifications according to Purnomo [10],[11]. Data retrieval is done by direct observation using measuring instruments in the form of rulers, calipers, and 3D printed cones to measure the grip diameter shown in Figure 1.

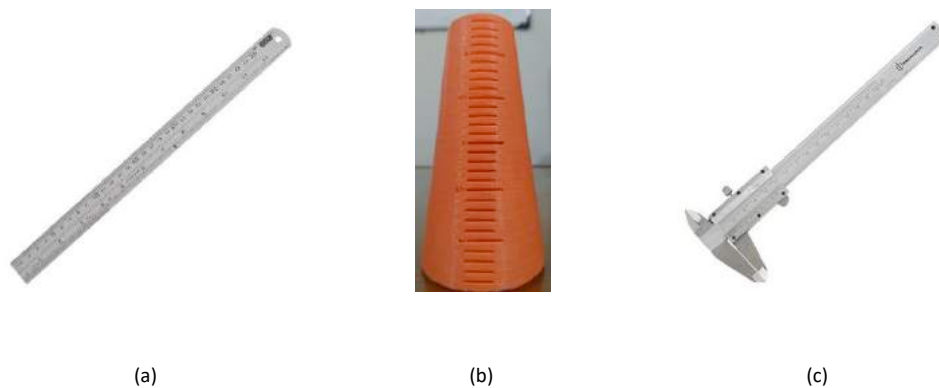


Figure. 1. Hand Anthropometry Measuring Instrument, (a) Ruler, (b). 3D Printed Cones, (c). Caliper

The collected data is processed by the normality test to find out the data from the samples that belong to the population with normal distribution. All collected anthropometric size data are then validated using control charts to check and ensure the data obtained does not come out of the control limit value. Furthermore, the 50-th percentile data was taken for use in research after all the dimensions collected were mapped and processed. The 50-th percentile is chosen because the data accommodates the entire user's hand. When the data collecting is completed, range of motion of human hand is determined. Range of motion determining is done by imitating the natural position of the human finger during the process of grasping the object. The imitation process is carried out on the middle finger and thumb when holding the object in the form of a cone that is used in measuring the grip diameter. The process of imitating human finger grips is done to get a range of motion. The grasping process is carried out on the object with the maximum grip diameter according to the average data obtained.

All the collected data used to build the linkage. The design of the linkage system that is used on the finger is a double crossbar system that is driven by a pull system at the base of the finger. The design consists of several link constituent parameters which are adjusted to the size of the anthropometry that has been obtained.

3. RESULTS AND DISCUSSION

3.1 Anthropometric Measurement of Human Hand

All anthropometric measurement data include the average size, standard deviation, and percentile size shown in Table 1. The data is then processed to be used as a basis for measurement in this study.

Table 1. Average, Standard Deviation, and Percentile Dimensions of the Hand

Hand Dimension	\bar{x}	σ	Percentile (mm)		
			5th	50th	95th
Width of Thumb	16.41	2,15	13.98	16.41	18.83
Length of Thumb	57.86	6,06	47.96	57.86	67.76
Width of Index Finger	15.16	2,01	12.57	15.16	17.75
Length of Index Finger	82.94	10,17	67.22	82.94	98.66
Width of Middle Finger	15.36	2,35	12.43	15.36	18.28
Length of Middle Finger	90.96	11,99	73.73	90.96	108.19
Width of Ring Finger	14.48	1,86	12.27	14.48	16.68
Length of Ring Finger	83.01	12,24	65.81	83.01	100.21
Width of Little Finger	12.34	1,87	9.69	12.34	14.98
Length of Little Finger	66.14	9,33	52.46	66.14	79.81
Length of the Hand	172.76	14,00	151.86	172.76	193.66
Length of Hand Palm	99.55	10,39	75.59	99.55	123.51
Width of Metacarpal	72.5	7,77	62.03	72.50	82.96
Hand Width	87.89	9,60	74.36	87.89	101.42
Thick of the Hand	30.67	8,00	21.71	33.79	45.88
Thick of Metacarpal	25.27	6,28	15.15	24.25	33.35
Thick of Thumb	14.84	2,56	8.5	14.84	21.19
Thick of Finger	13.94	3,12	8.34	13.94	19.54
Hand Holding Width	83.97	12,71	63.82	83.97	104.12
Hand Holding Length	102.48	13,69	79.25	102.48	125.7
Width of Thumb to Little Finger	183.33	20,31	151.65	183.33	215.01
Maximal Hand Grip	47.85	6,64	37.75	47.85	57.95
Minimal Hand Grip	5.28	2,68	1.09	5.28	9.47
Length of Fist	58.78	6,05	47.91	58.78	69.66
Width of Fist	83.31	11,17	66.85	83.31	99.77

From the data above, finger length can be determined using ratio of 5: 4: 3 for the middle finger and 5: 4 for the thumb. The middle finger and thumb length shown in Table 2.

Table 2. Finger Length

Finger Segment	Length (mm)	
	Thumb	Middle Finger
Phalanx Proximal	32,14	37,90
Phalanx Media	-	30,32
Phalanx Distal	25,72	22,74

3.2 Determining Range of Motion

The grasping process is carried out on the object with the maximum grip diameter according to the average data obtained in Table 1 which is 48 millimeters. The process of mimicking the grip on the thumb and the middle finger is done as in and it is known that the range of motion is formed as shown Figure 2.

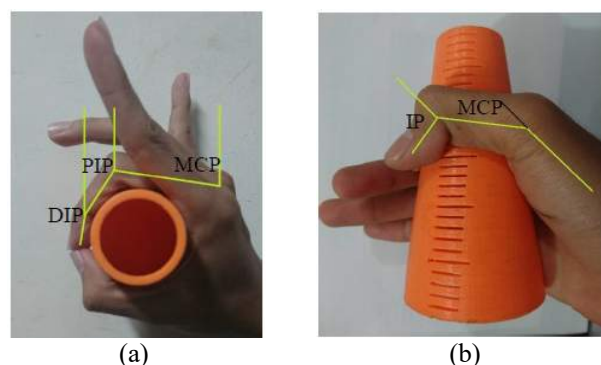


Figure 2. Acquisition of ROM, (a) Middle Finger, (b). Thumb

From the picture above can be obtained ROM on each finger segment shown in Table 3.

Table 3. ROM Acquisition of Joints

<i>Joints</i>	Range of Motion
<i>MCP Joint</i>	34°
<i>PIP Joint</i>	87°
<i>DIP Joint</i>	142°
<i>MCP Joint (Thumb)</i>	38,50°
<i>IP Joint (Thumb)</i>	101,11°

The range of motion and finger length that have been obtained are then used as the basis for designing the finger mechanism, so that the design of the finger to be created has the same ROM as the original human finger.

3.3 Design of the Finger Linkage System

In the design of linkage there are two designs of the designed finger mechanism, which includes the thumb and middle finger.

a. Thumb Linkage

The thumb mechanism is designed using a crossbar system. Design the prosthetic mechanism of the anthropomorphic fingers, as shown in Figure 3.

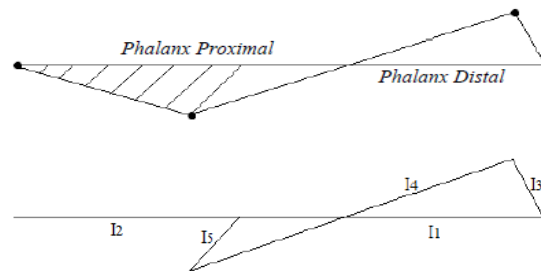


Figure 3. Thumb Linkage Mechanism

The length of each link in the image above is described in the data in Table 4. The lengths and angles that have been determined are used to illustrate the simulation of finger movements during the gripping process. The graph of the mechanism of finger movements looks like Figure 4.

Table 4. Link Length of the Design Parameters of the Thumb

Link	Length (mm)
I ₁	32.14
I ₂	25.72
I ₃	5.00
I ₄	31.21
I ₅	2.10

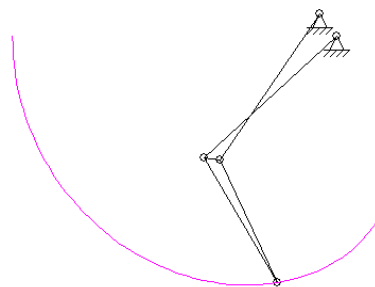


Figure 4. Thumb Mechanism Movement

b. Middle Finger Linkage

The middle finger mechanism is designed using double crossbar system. Design the prosthetic mechanism of the anthropomorphic fingers, as shown in Figure 5.

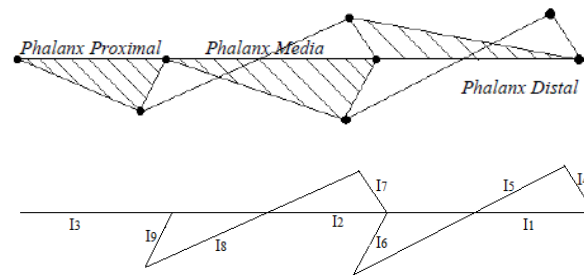


Figure 5. Middle Finger Linkage Mechanism

The length of each link in the image above is described in the data in Table 5. The lengths and angles that have been determined are used to illustrate the simulation of finger movements during the gripping process. The graph of the mechanism of finger movements looks like Figure 6.

Table 5. Link Length of the Design Parameters of the Middle Finger

Link	Length (mm)
I ₁	38.26
I ₂	29.88
I ₃	22.82
I ₄	8.50
I ₅	37.57
I ₆	3.40
I ₇	3.50
I ₈	29.87
I ₉	2.10

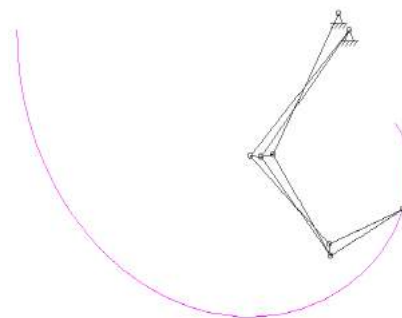


Figure 6. Middle Finger Mechanism Movement

4. CONCLUSION

In this study the prosthetic design of anthropomorphic 1-DOF fingers with a driving mechanism on the link at the base of the finger using a pull system to minimize the possibility of buckling is produced. The design of the anthropomorphic fingers is designed based on the similarity of the angle position and the total length of the finger when the fingers of the human hand hold maximum. To develop the prosthetic design of the anthropomorphic fingers, further research is needed on the application of the linkage system that has been made to the prototype so that the accuracy of the range of motion produced in the prototype is known.

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PROPS DESIGN ON MANUAL ASSEMBLY LINES IN INDUSTRIAL ENGINEERING DESIGN PRACTICUM 3 WITH LEARNING FACTORY APPROACH

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Abstract. Industry requires educational institutions as providers of labor to continue to optimize the learning process on material that is in harmony with existing cases in the industrial world. The Industrial Engineering Study Program of Sebelas Maret University Surakarta (PSTI-UNS) has sought these demands by implementing integrated practice learning with the learning factory concept approach. Identification of design needs was obtained after observations and evaluations of the learning process on PTI Practicum 3. This study contains requirements in designing tools to accommodate lab work in linear PTI Practicum manuals. The tools needed include storage, hand trolleys, storage racks, and work stations. The selection of the work station concept was carried out with Focus Group Discussion (FGD) with specified selection criteria. The criteria for selecting a tool for practicum facilities include the suitability of learning objectives, material

Keywords : Props, Manual Assembly Line, Learning Factory.

1. INTRODUCTION

Industry requires educational institutions as providers of labor to continue to optimize the learning process on material that is in harmony with existing cases in the industrial world. The Industrial Engineering Study Program of Sebelas Maret University Surakarta (PSTI-UNS) has sought these demands by implementing integrated practice learning with the learning factory concept approach. According to Tisch et al [1]. Learning factory is a learning approach oriented to the competency of participants through a structured independent learning process in a learning environment with actual industrial problems. Learning factories provide a production environment where only small abstractions are possible from processes and technology in real industrial sites Abele et al., [2]. The application of the concept of learning factory learning was applied by PSTI-UNS through the implementation of integrated practicum with the name of the Practical Engineering Design Industry (PTI). One of the practical steps that is still being evaluated is PTI Practicum 3. Practicum PTI 3 is a third stage integrated practicum which plays a role in the assembly process on manual assembly lines to assemble the products produced on PTI 2 Practicum.

The implementation and development of PTI Practicum 3 has been started since 2015 directed at manual assembly lines for the assembly of lecture chairs. However, practicum implementation on manual assembly lines is still not accommodated with assistive devices as a practical facility. The assembly process at each work station is still carried out on the floor without tools or practical facilities in the form of work station tables and other supporting practical facilities. The condition of the work station makes the product components and assembly equipment not neatly arranged. Each work station is not equipped with standard work procedures so that in one station there are many operators who handle the assembly process.

Learning factories are based on developing competencies needed by trainees. Based on these competencies, the level of learning (teaching methods, media and learning processes) as well as technological infrastructure (manufacturing processes) are formed and harmonized to complete the learning factory design in the description of the industry [1]. PTI 3 practicum that has been running so far has not provided an overview

of the form of manual assembly lines due to the lack of accommodating tools as learning media.

The design of assistive devices as a practicum facility is carried out by carrying out product development steps by Ulrich and Eppinger [3]. The design of a tool is also designed based on the learning factory concept approach. The basic principle of learning factory is to integrate equipment and materials into manufacturing systems and integrate various roles in manufacturing into effective teams in designing and producing products and processes (Lamancusa, [4]). According to Ogorodnyk [5], running a copy of the manual assembly line gives students the opportunity to see possible challenges and problems that might arise in the assembly line that is applied in the actual company.

2. METHODS

Identification of design needs was obtained after observations and evaluations of the learning process on PTI Practicum 3. Evaluation of the needs of tools in the manual assembly line practicum was previously conducted to determine the needs of any tools needed for manual assembly line practicum. Evaluation is done by identifying the needs of the tools needed in each assembly line practicum process. The results of the needs of the tools needed in each process are explained as follows:

- Taking part in warehouse, this process requires a tool in the form of a warehouse / storage to put all the parts that will be sent to each work station. Storage function to hold all parts and group parts into the same type.
- The process of sending parts to work stations, this process requires maternal handling transport to facilitate operators in carrying parts.
- The process of assembling parts at work stations, this process requires a work station table and shelves as a place to store temporary parts. Work station table is used for assembling parts. The shelf serves as a place while the new part comes from the warehouse.
- In the quality control process, the customer and PPIC places only need a table

3. RESULTS AND DISCUSSION

3.1 Preparation of Alternative Concept Tools

Before the drafting of alternative design concepts will be presented in Figure 1 regarding alternatives for the concept of work stations, the concept of storage systems, the concept of equipment transport materials and materials used as a framework for tools.



Figure 1. Alternatives for the concept of work stations, the concept of storage systems, the concept of equipment transport materials and materials used as a framework for tools.

a. Alternative Storage Design Concepts

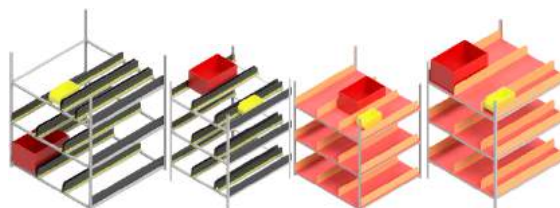


Figure 2. Alternative storage design

b. Alternative Concept of Hand Trolley Design

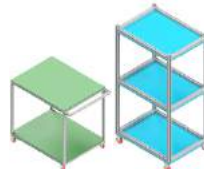


Figure 3. Alternative hand trolley design

c. Alternative Design Concept of rack storage

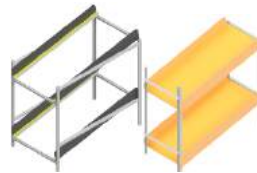


Figure 4. Alternative rack storage design

d. Alternative Work Station Design Concepts



Figure 5. Alternative Work station design

3.2 Selection of Alternative Concept Tools

The concept assessment stage is carried out by assessing all alternative concepts towards the criteria that have been determined. Assessment is based on the needs and characteristics of each existing concept. Concept assessment is done by FGD (Focus Group Discussion) which involves 2 designers, 2 stakeholders, and 1 manufacturing person. Concept assessment is explained in table 1 below.

Table 1. Average, Standard Deviation, and Percentile Dimensions of the Hand

Alternativ Criteria	Storage				Hand Trolley		Rack Storage		Work Station	
	I	II	III	IV	I	II	I	II	I	II
Suitability of learning objectives	3			2		5		5	5	
Material availability				5	2	3		5	4	1
Technical quality	3		2			5	3	2	5	
Procurement cost				5	2	3		5		5
Tool flexibility	2		2	1	1	4	1	4	3	2
Ease of use	2			3		5	2	3	5	
Time allocation	3			2		5	3	2	5	
Total Score	13	0	4	18	5	30	9	26	27	8
Decission	Alternative IV				Alternative II		Alternative II		Alternative I	

Based on the results of the concept assessment, alternative concepts are chosen that have high values so that the concept of alternative 4 is obtained for storage, alternative concept 2 for hand trolley, alternative 2 for rack storage and alternative 1 for work stations.

The alternative storage concept 4 was chosen based on the availability of material and the costs needed were lower. Because the iron components are hollow and plywood is very easy and fast to get right and a cheap price. This concept is easy to use and understand for the user because each component of the assembly only needs to be placed according to its component group. The flexibility of this concept is quite sufficient where the tool can be assembled and adjustable in height, except that it requires precision in mounting between holes though. The allocation of time needed is also sufficient even though it is easier in assembly in the storage 1 alternative concept.

Alternative hand trolley 2 concept was chosen because it prioritizes the use of aluminum extrusion as the main framework. The use of aluminum extrusion makes the quality of the hand trolley more robust and easy to install. Dimensions that are not wide or utilize dimensions towards the vertical make the hand trolley not too space consuming. This concept is also easy to understand for users as media handling material handling to make it easier to carry assembly components from rack to storage storage.

The alternative concept of rack rack 2 is chosen because it prioritizes the use of hollow elbow iron as the main framework and use of plywood as a storage rack base. The use of perforated iron makes rack storage can be dismantled. This concept has been fulfilled as a learning medium to describe a storage or temporary placement of assembly components before being assembled. But in the manufacturing process it will take a long time because of the high accuracy needed to assemble this concept.

The alternative concept of kerja 1 station was chosen because it prioritized the use of aluminum extrusion as the main framework although the cost of producing this concept was quite expensive. The use of aluminum extrusion makes the quality of the work station more robust and easy to install. The use of plywood as a base is strong enough to hold the workpiece load. This concept is also easy for the user to understand as a work station learning media to describe work stations on manual assembly lines.

4. CONCLUSION

This study contains requirements in designing tools to accommodate lab work in linear PTI Practicum manuals. The tools needed include storage, hand trolleys, storage racks, and work stations. The selection of the work station concept was carried out with Focus Group Discussion (FGD) with specified selection criteria. The criteria for selecting a tool for practicum facilities include the suitability of learning objectives, material availability, technical quality, procurement costs, tool flexibility, ease of use, and time allocation. The chosen concept is alternative 4 for alternative storage design concepts, alternative 2 for hand trolley, alternative 2 for rack storage, and alternative 1 for work stations

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