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PICK AND PLACE THREE VARIOUS RINGS USING KUKA ROBOT

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ABSTRACT

This paper focusing on developing a programmed code for pick and place three objects using KUKA robot. The objects are different in material and diameters. This task is accomplished by using KUKA robot, KR-16KS. Point-to-point motion is used rather than linear and circular motion to achieve fastest cycle program. In this task, the rings need to be picked and placed into the specified location. The motions of this task are programmed in KUKA robot control panel. The programmed is tested by using KUKA robot and from the experimental result, this programme has achieved 13.62s by using overwrite speed 50%.

KEY WORDS: *KUKA robot; pick and place operation; point to point motion*

1. INTRODUCTION

KUKA name stand for Keller und Knappich Augsburg. The KUKA robot is an industrial robot for variety of industry, defined by as a reprogrammable, automatically controlled, multipurpose manipulator programmable in six axes. The advantages of industrial robot are quality, saving, production and safety. Typical application of these robots includes assembly, pick and place, welding, and painting. Most of KUKA robot comes in orange or black color and with control panel, KCP that used for teaching and operating the corresponding KUKA robot controller and thus constitutes the human-machine interface.

Pick and place application in industrial focuses on to take a product from one position/location in the manufacturing process and drop it into another position/location. One type of robot used this application is Pick and Drop Robot. For the example, the robot uses to pick objects off a conveyor belt and placing it into packaging boxes. It have many benefits to industrial when using the pick and place application of the robot. The benefits are decrease production cost, increase efficiency, ideal for hazardous condition especially in industrial and increase the efficiency (Niku, 2001).

As usual pick and place application requires high amounts of repetitive motion and long hours. Many factors must be controlled carefully to achieve flawless and smooth operation of the pick and place process. The factors affecting the picking process includes the objects shape, objects position, the robot arm trajectory and the end effectors of the robot. After completing the picking process, the robot will move to place the objects inside the designated box.

Typically pick and place application of robot involves multiple moves and often requires interaction with sensor or external hardware. According to the "SPARA" (Systkme de Programmation Automatique pour la Robotique d'AssembIage) system, there are several steps for pick and place task. There are (Mazon, 1990):

- A transfer motion from the initial robot position to a point near the object to be picked.
- The grasp/pick action itself.
- A depart motion from the pick position to a position where a transfer motion can be performed.
- A transfer motion in order to bring the object near its final destination.
- An approach motion in order to place the object.
- An ungrasped/releasing the object action.
- A depart motion from the place position to a position where a transfer motion can be performed.
- A transfer motion in order to bring the robot to its final position.

This report is focusing on developing a programmed code for pick and place three objects using KUKA robot. The model number of this KUKA robot in this task is KR-16KS. The purposes of this task as following:

i. To familiarize programming a robot system using a control pendant.
ii. To know the importance of cycle times of a manufacturing cell and the effect of robot tool paths upon cycle times.
iii. To recognise the benefits and shortcomings of 6-axis design robots.
iv. To familiarize the KUKA robot for a typical industrial application.

2. METHODOLOGY

This section explain details about the work pieces, operation flow and programming involved and the model number of KUKA robot use in this task is KR-16KS.

2.1 The work pieces

Three different objects with different mass and sizes are used to complete this task. The objects are ring shape and can be divided into three types as following:

Table 1: Types of Rings

No.	Ring type	Label	Diameter (cm)
1	Sellotape	O1	7.5
2	Rubber Band	O2	4
3	Steel Ring	O3	3

The program should be capable of picking up the whole object from different position and placing them in a box. The whole objects are located in different angle and the distance around 30 to 60 cm. the location of these three rings is shown in figure 1. Figure 2(a),(b),(c) show the arrangement of three rings in experimental setup. The three rings are placed on the same table size. The height of the placement of three rings are not same. In order to accomplish this task, some of rules must be followed. The task criteria are:

i. The robot must be able to pick three objects, and place it inside the box.
ii. The distance from one ring to next ring must not less than 15 cm.
iii. The setup programming able to achieve shortest cycle time to accomplish this task.

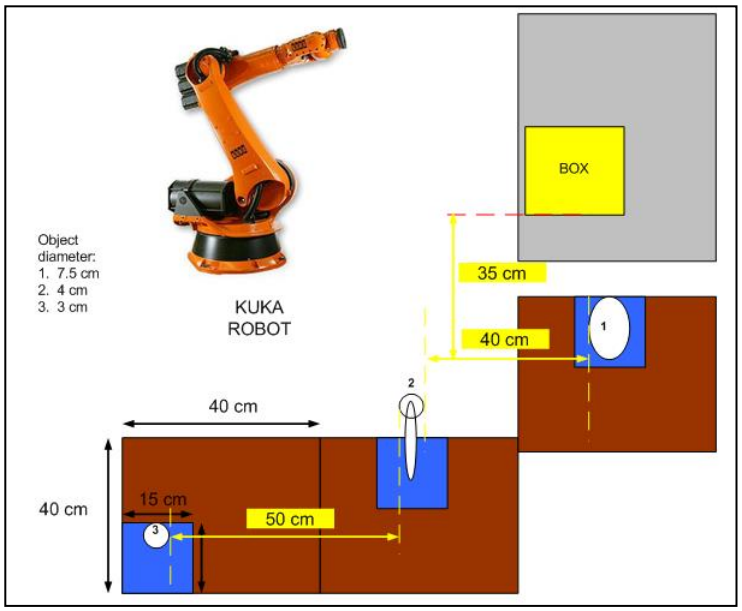

Figure 1: Arrangement of Three Objects

(a) (b) (c)

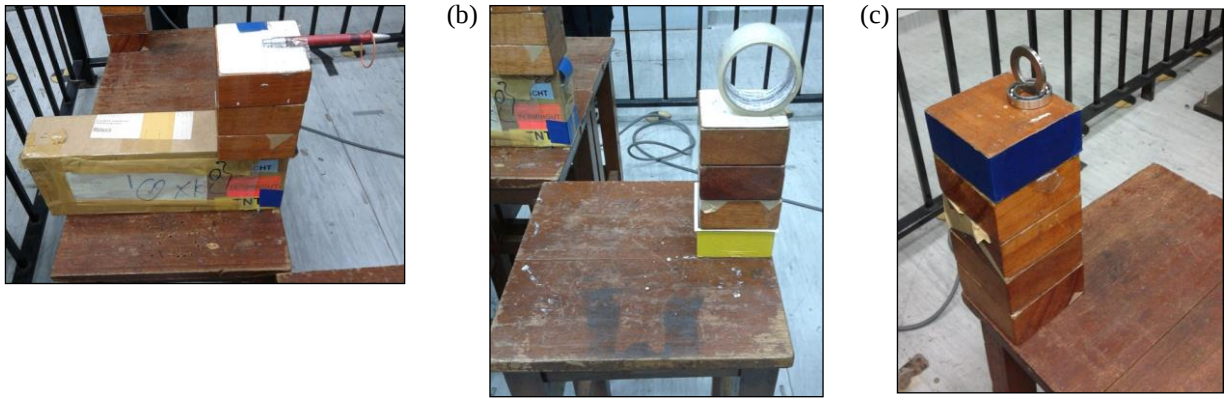

Figure 2: Arrangement of Three Rings in experimental Setup (a) Sellotape (b) Rubber band (c) Steel Ring

2.2 Operation Flow

The KUKA robot operation flow is shown in figure 3. First, the robot is set to pick sellotape (O1) and put the sellotape to the box. Next, the robot will take second ring and third ring which are rubber band (O2) and steel ring (O3) and place the objects into the box. This operation not taken three rings simultaneously to avoid the robot unable to place any ring into the box. Therefore, cautious step has been taken by picking and placing first ring and next to pick and place second and third ring.

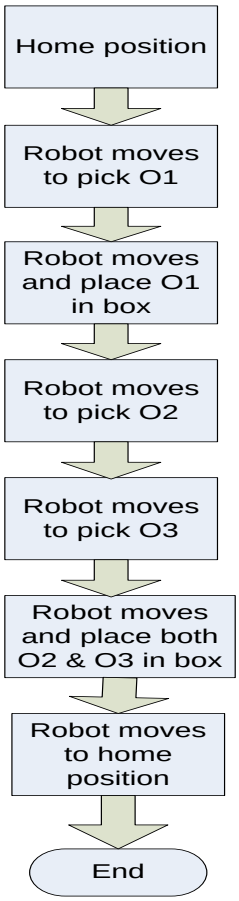

Figure 3: The KUKA Robot Operation Flow

2.3 Programming

There are three common types of motion in KUKA robot which are point-to-point (PTP), linear (LIN) and circular (CIR). Distinction between these three types of motion are described in details as following:

2.3.1 Linear (LIN)

LIN is the motion in straight line across one axis or motion at a defined acceleration and velocity along a straight line. The start point comes from previous point and end/last point comes from current command in straight line between both points. Linear motion requires programmers to teach one point.

2.3.2 Point to Point (PTP)

PTP is the faster way of robot can move from one point to another point. This motion also requires programmers to teach one point (set point), stop, complete its task, and then move to the next set point.

2.3.3 Circular (CIRC)

CIRC is only way that requires programmer to teach two points. Start point comes from end point in the previous command, and then the robot goes to mid-point of circular path and to the last point.

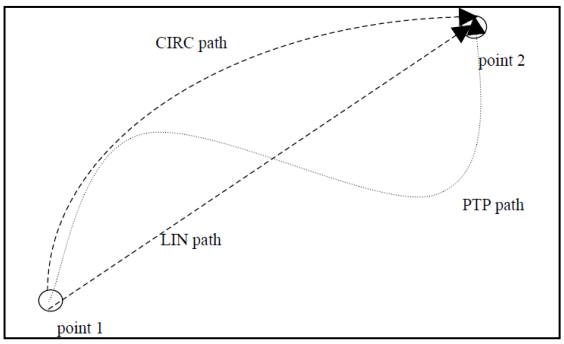

Figure 4: Three Types of Common Motion in KUKA Robot

Figure 4 shows the three common motions which are PTP, linear and circular. PTP motion is believed as the fastest motion compared to other motions and circular motion is the slower motion. In this task, only PTP motion is used to accomplish pick and place task. The programming code was developed using the KUKA Control Panel. The programmed code is shown in Fig. 5. From the figure, PTP is only motion used in this programmed. In PTP motion, the speed is unable to determine and as a reference the velocity is 100%. The speed of PTP motion is dependent on overwrites speed that has been setup while running the programme.

```
1   INI
2
3   PTP HOME  Vel= 100 % DEFAULT
4   PTP P11  Vel= 100 % PDAT11 Tool[1]:toolscrew Base[0]
5
6   PTP P1  Vel= 100 % PDAT1 Tool[1]:toolscrew Base[0]
7   PTP P2  Vel= 100 % PDAT2 Tool[1]:toolscrew Base[0]
8   PTP P12  Vel= 100 % PDAT12 Tool[1]:toolscrew Base[0]
9   PTP P4  Vel= 100 % PDAT4 Tool[1]:toolscrew Base[0]
10  PTP P15  Vel= 100 % PDAT15 Tool[1]:toolscrew Base[0]
11  PTP P5  Vel= 100 % PDAT5 Tool[1]:toolscrew Base[0]
12  PTP P14  Vel= 100 % PDAT14 Tool[1]:toolscrew Base[0]
13  PTP P6  Vel= 100 % PDAT6 Tool[1]:toolscrew Base[0]
14  PTP P7  Vel= 100 % PDAT7 Tool[1]:toolscrew Base[0]
15  PTP P8  Vel= 100 % PDAT8 Tool[1]:toolscrew Base[0]
16  PTP P9  Vel= 100 % PDAT9 Tool[1]:toolscrew Base[0]
17  PTP P10  Vel= 100 % PDAT10 Tool[1]:toolscrew Base[0]
18  PTP HOME  Vel= 100 % DEFAULT
19
```

Figure 5: Programmed Code for Pick and Place Task

3. ANALYSIS OF FORWARD AND INVERSE KINEMATICS

A commonly used method for selecting frames of reference in robotic applications is the Denavit-Hartenberg, or D-H convention. In this method, each homogeneous transformation A_i is represented as a product of four basic parameters:

θ_i: joint angle (the angle between x_{i-1} and x_i measured about z_{i-1})
d_i: link offset (the distance along z_{i-1} from o_{i-1} to the intersection of the x_i and z_{i-1} axes)
α_i: link twist (the angle between z_{i-1} and z_i measured about x_i)
a_i: link length (distance along x_i from o_i to the intersection of the x_i and z_{i-1} axes)

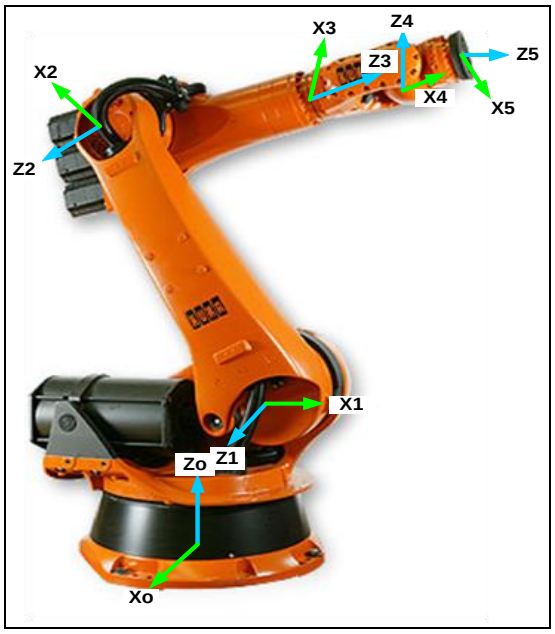

Figure 6: Joints of KR-16KS Robotic Arm

Figure 6 shows the joints of KR-16KS robotic arm. After the entire x and z axes for the robot arm has been determined, the D-H parameters table is tabulated. Table II shows the D-H parameters for six joints.

Table 2: D-H Parameters

#	θ	d	α	a
1	θ_1	0	90	0
2	θ_2	0	0	a_2
3	θ_3	0	0	a_3
4	θ_4	0	-90	a_4
5	θ_5	0	90	0
6	θ_6	0	0	0

The transformation matrixes for all 6-axes are as shown below.

$$A_1 = \begin{bmatrix} C_1 & 0 & S_1 & 0 \\ S_1 & 0 & -C_1 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$A_2 = \begin{bmatrix} C_2 & -S_2 & 0 & a_2C_2 \\ S_2 & C_2 & 0 & a_2S_2 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$A_3 = \begin{bmatrix} C_3 & -S_3 & 0 & a_3C_3 \\ S_3 & C_3 & 0 & a_3C_3 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$A_4 = \begin{bmatrix} C_4 & 0 & -S_4 & a_4C_4 \\ S_{34} & 0 & C_4 & a_4S_4 \\ 0 & -1 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$A_5 = \begin{bmatrix} C_5 & 0 & S_5 & 0 \\ S_5 & 0 & -C_5 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$A_6 = \begin{bmatrix} C_6 & -S_6 & 0 & 0 \\ S_6 & C_6 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

The total transformation between the base of the robot and the hand ca be obtained by transforming all matrices from A_1 until A_6, started with the first joint and then transform to the second joint, then to the third until to the arm-end of the robot, and eventually to the end effectors (Niku 2001).

$$^{R}T_H = A_1\,A_2\,A_3\,A_4\,A_5\,A_6 = \begin{bmatrix} n_x & o_x & a_x & p_x \\ n_y & o_y & a_y & p_y \\ n_z & o_z & a_z & p_z \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$A_1\,A_2 = \begin{bmatrix} C_1C_2 & -S_2C_1 & S_1 & a_2C_1C_2 \\ S_1C_2 & -S_1S_2 & -C_1 & a_2S_1C_2 \\ S_2 & C_2 & 0 & a_2S_2 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$A_1\,A_2\,A_3 =$

$$\begin{bmatrix} C_1C_{23} & -C_1S_{23} & S_1 & a_2C_1C_2 + a_3C_1C_{23} \\ S_1C_{23} & -S_1S_{23} & -C_1 & a_2S_1C_2 + a_3S_1C_{23} \\ S_{23} & C_{23} & 0 & a_2S_2 + a_3S_{23} \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$A_1\,A_2\,A_3\,A_4 =$

$$\begin{bmatrix} C_1C_{234} & -S_1 & -C_1S_{234} & a_2C_1C_2 + a_3C_1C_{23} + a_4C_1C_{234} \\ S_1C_{234} & -C_1 & -S_1S_{234} & a_2S_1C_2 + a_3S_1C_{23} + a_4S_1C_{234} \\ S_{234} & 0 & C_{234} & a_2S_2 + a_3S_{23} + a_4S_{234} \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$A_1\,A_2\,A_3\,A_4 =$

$$\begin{bmatrix} C_1C_{234} & -S_1 & -C_1S_{234} & a_2C_1C_2 + a_3C_1C_{23} + a_4C_1C_{234} \\ S_1C_{234} & -C_1 & -S_1S_{234} & a_2S_1C_2 + a_3S_1C_{23} + a_4S_1C_{234} \\ S_{234} & 0 & C_{234} & a_2S_2 + a_3S_{23} + a_4S_{234} \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$A_1\,A_2\,A_3\,A_4\,A_5 =$

$$\begin{bmatrix} -S_1S_5 + C_1C_{234}C_5 & -C_1S_{234} & -S_1C_5 + C_1C_{234}S_5 & a_2C_1C_2 + a_3C_1C_{23} + a_4C_1C_{234} \\ -C_1S_5 + S_1C_{234}C_5 & -S_1S_{234} & -C_1C_5 + C_1C_{234}S_5 & a_2S_1C_2 + a_3S_1C_{23} + a_4S_1C_{234} \\ S_{234}C_5 & C_{234} & S_{234}S_5 & a_2S_2 + a_3S_{23} + a_4S_{234} \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$^{R}T_H = A_1\,A_2\,A_3\,A_4\,A_5\,A_6$

$n_x = -C_1S_{234}S_6 + C_1C_{234}C_5\,C_6 - S_1S_5S_6$

$n_y = -S_1S_{234}S_6 + S_1C_{234}C_5\,C_6 - C_1S_5S_6$

$n_Z = C_{234}S_6 + S_{234}C_5C_6$

$o_x = -C_1S_{234}C_6 + C_1C_{234}C_5\,S_6 - S_1S_5S_6$

$o_y = -S_1S_{234}C_6 + S_1C_{234}C_5\,S_6 - C_1S_5S_6$

$o_Z = C_{234}C_6 + S_{234}C_5S_6$
$a_x = C_1C_{234}S_5 - S_1C_5$
$a_y = S_1C_{234}S_5 - C_1C_5$
$a_Z = S_{234}S_5$
$p_x = C_1(a_2C_2 + a_3C_{23} + a_4C_{234})$
$p_y = S_1(a_2C_2 + a_3C_{23} + a_4C_{234})$
$a_Z = a_2S_2 + a_3S_{23} + a_4S_{234}$

For forward kinematic analysis, several formulas can be used, depending on the types of movements made by the robot.

i. Translational movement

$$\begin{bmatrix} 1 & 0 & 0 & p_x \\ 0 & 1 & 0 & p_y \\ 0 & 0 & 1 & p_z \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Where: p_x = translation at x-axis
p_y = translation at y-axis
p_z = translation at z-axis

ii. Rotational movement
(a) About x-axis

$$\begin{bmatrix} 1 & 0 & 0 \\ 0 & cos\theta & -sin\theta \\ 0 & sin\theta & cos\theta \end{bmatrix}$$

(b) About y-axis

$$\begin{bmatrix} cos\theta & 0 & sin\theta \\ 0 & 1 & 0 \\ -sin\theta & 0 & cos\theta \end{bmatrix}$$

(c) About z-axis

$$\begin{bmatrix} cos\theta & sin\theta & 0 \\ -sin\theta & cos\theta & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

4. RESULTS AND DISCUSSION

The programmed code has been tested on the KUKA robot. By setting the overwrite speed to 50%, this task has achieved fastest total time which is 13.62 s. This programmed code has been compared with two other programmed codes which have been implemented in the same task but different in arrangement of three rings and box and different in programmed code. The first group and second group have programmed the code by picking three various rings first and place the rings in the box. Different in our group, we have picked first ring and placed the ring into the box. Next, to pick second and third ring and place them into the box. Even though, this programmed seems slow due to the three rings are not taken simultaneously but the experiment has proved this programmed able to achieve fastest total time.

In order to achieve the fastest total time, some considerations must be taken such as selection of motion and arrangement of rings. Instead of using slower motion such as linear and circular, PTP motion should be chosen as the best selection motion in pick and place task (Cooper et al. 2019). The comparison results is shown in Table 3. From the results, the proposed programmed code has achieved the fastest time in pick and place three various rings.

Table 3: Comparison of Experimental

Group	Overwrite speed (%)	Total time (s)
1	30	19
2	50	16
Our group	**50**	**13.62**

5. CONCLUSION

From the experiment, by using overwrite speed 50% and PTP, the programmed code has achieved the fastest time in pick and place three various rings which is 13.62 s. In the future, the total time can be decreased by increasing the overwrite speed to achieve the fastest total time.

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EXPERIMENTAL SETUP ON SMALL-SCALE POWER GENERATOR FOR ENVIRONMENTAL VALUE

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ABSTRAK

Power generator is designed to save electricity. This is because there is a lot if electric wastage in this world. There are many types of generator that do not save electricity. Nevertheless, the product that we created not only save the electricity, it also save the planet and save our money. Next, most of the product in the market do not have a way to save the earth by using natural resources. As a solution, we created this product for saving our money to pay the electricity bills. Moreover, this product has been upgraded with turbine installment. Therefore, the operation of a generator is based on the principles discovered by Faraday. Next, to operate this product it used the water from main tank house. Apart from that, the methods that we use is a hydraulic turbine converts the energy of flowing water into mechanical energy. Although, a hydroelectric generator converts this mechanical energy into electricity. Besides that, we want to introduce to the world that electric system can be changed for the sake of the future. Although, this product is use of the hardware. Also, this generator can be used at house. As a conclusion, we as a new generation must think about the future so there will be many products that are produced devoted to natural resources.

KEYWORDS: *power generator, turbine, electric*

1. INTRODUCTION

There are many types of generator, but that do not save electricity. So the product that created not only save electricity but it save the planet and save the money. For example, the lights are switching on even days are already noon. From this, we found that electricity bills are rising due to wastage. We are also looking for resources to save electricity bills using natural resources. The problem here is the natural resources need to be generated using another tool. Conclusion, the water source will be processed to generate electricity using the dam. How does the dam want to be placed in a house? It is impossible. So, after the research and combine the ideas we wanted to create a tool that help to save electricity in a house. We narrow the scope of work from the dam to be replace new scope to can place at house for generates electricity and store the electric in the battery.

2. LITERATURE REVIEW

Hydropower is one of the oldest power sources on the planet, generating power when flowing water spins a wheel or turbine. Hydropower is also a renewable energy source and produces no air pollution or toxic byproducts. Thus, every state uses hydropower for electricity, and some states use a lot of it. In fact, there are over 70 percent of Washington State's electricity comes from hydropower, and 11 states get more than 10 percent of their electricity from hydropower. Nevertheless, hydropower costs less than most energy sources. However, some states that get the majority of their electricity from hydropower, like Idaho, Washington, and Oregon, have energy bills that are lower than the rest of the country. By that, we can see by using hydropower we also can save money.

This project focus on how help the earth by reducing global warming from getting worse in the future. Other than that, wastage of money and electricity also inspiring us to make this product. Our product POWER GENERATOR are designed for produce a continuous power in which a wheel or turbine. It's typically fitted with vanes, it's also made to revolve by a fast-moving flow of water. Moreover, by using this product we will generates electricity using water from the main tank. So, from there water will flow at turbine while the Power Generator generates the power and save at the battery.

3. Methodology

In this project, hardware and software method are proposed to develop the research solution. The designed Power Generator is easy to control manually, which is work based on water from tank. Turbine will be operated when the water flow through it and will generate the power to charge the battery and activate the inverter. AC will operator depend on that pressure of water which the value of KpI have been reach. In addition, the design of Power Generator more safety for the user because it not heavy machine. The results of this project will be technically and clinically tested to determine the suitability for home installation.

3.1. Hardware specification

- Turbine
- Battery
- Inverter
- LED Display
- PVC
- Charging Circuit

3.2. Analysis and result

The analysis was done for charging circuit .Besides that the using of both load and no load in this project also have been analysed with the appropriate way to get better result. There are the detection by LED battery Level.

Table 1. Comparison Battery between Load and No Load

TIMING (min)	AC Value	LOAD (DC)	NO LOAD (DC)	PSI
0	240	9V	9.8V	15
8	240	11.3V	12V	15
16	240	11.3 V	12.4 V	15
30	240	11.3 V	12.6 V	15

From the table above we can said the Power Generator can be a supply for electricity and can store the battery if don't have a load.

4. RESULT

Figure 1 is the picture of connection hydroelectric. The result shows that the product was generate using water by the pump pressure. It was fully function if not using a water because the product have a battery. After using the product the battery is only 9.8V and the inverter does not release the output. The battery needs to recharge using the turbine and stored in the battery to remove the 12V DC output and then convert to 230V AC. We use water which at least has a pressure of 15 pSi to move the turbine so that it can be generated to get 12v output. It takes about 8 minutes 23 seconds to generate from 9.8V to 12.0V.

Figure 1: How to Generate the Power Generator

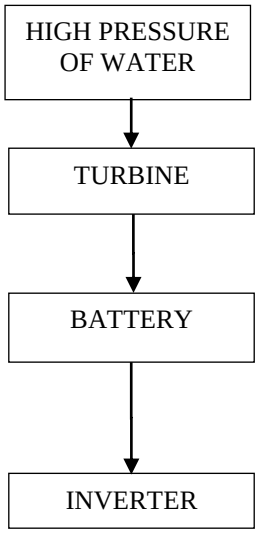

Figure 2: How the Circuit Works

Figure 2 is the block diagram our products have been innovated to be easy-to-carry and held products. Installation and application of our products only requires sufficient water pressure to drive the turbine to generate electricity. When electricity starts generating electricity by turbine, electricity will be thrown into 12v battery. We use the inverter to convert from 12v to 230v. Electricity from 230v output can be used.

Figure 3 Show how Installation of our products can be done in the main tank of the house. Throughout the main water tank will be discharged and proceed to POWER GENERATOR. Water pressure from the main tank can run the turbine to produce electricity. Modifications to installing our products do not require high costs according to our primary objective of saving. If installation is required at home or food premises, only pvc pipes and pvc connectors are required.

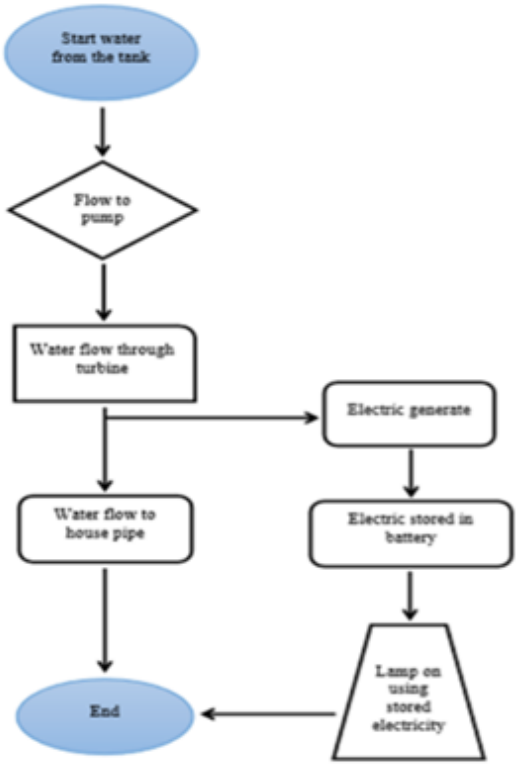

Figure 3: The Details

5. CONCLUSION

We can conclude, the hypothesis was right that we using the natural resources to generate electricity for home use. We also can reducing usage of electricity. The conserving family was able to save even more by using Power Generator. Other than that, more and more people are thinking about the environmental issues and ecological condition of Earth nowadays. Our planet suffers from numerous problems, which have been caused by the results of the excessive anthropogenic activity. Moreover, the entire planet suffers from pollution, global warming, deforestation and extinction of biological species. These problems are extremely relevant and require rapid and intensive solutions. So we created this product in particular to protect the environment and the earth from harm.

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CASE STUDY OF ENERGY COST AND GREENHOUSE GAS EMISSION AT SUSTAINABLE ENERGY LAKE RECREATION CENTER POLITEKNIK SULTAN AZLAN SHAH

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ABSTRACT

In Malaysia, the reduction of greenhouse gas emissions is an area of intense focus in line with the government's commitment in Copenhagen in 2009 towards reducing carbon dioxide emissions through energy efficient management systems. Based on the problems faced by consumers in low-cost areas to obtain electricity, the use of lighting equipment using solar-powered electricity is more cost effective. This paper presents a case study of the potential of carbon reduction through the reduction of the use of electricity generated by fossil fuel to zero level and determine the energy cost saving by applying the solar system by adopting the case study sample of mini solar farm at Sustainable Energy Lake Recreation Center, Politeknik Sultan Azlan Shah (SELReC PSAS). PSAS is constantly raising the level of applications that applied energy sustainability for the space available in its area. Through the development of a mini-solar farm with approximately 1kW capacity which it is also a strategy to attract citizens towards environmental sustainability through renewable energy application. The mini solar farm proves that the generated electricity can contribute to the Greenhouse Gas (GHG) emission especially carbon dioxide (CO_2) reduction.

KEYWORDS: *Energy cos efficiency, SELReC, carbon emission, solar PV, GHG, CO_2*

1. INTRODUCTION

Malaysia Prime Minister had announced at the 15th Conference of Parties (COP15) in Copenhagen, Malaysia would voluntarily reduce its emissions intensity of gross domestic product (GDP) by up to 40% by 2020 based on 2005 levels (The Academy of Sciences Malaysia, 2013). This initiative, which is conditional to technology transfer and financial support from developed countries, demonstrates Malaysia's commitment to addressing greenhouse gas (GHG) emissions in the context of sustainable development.

Renewable Energy (RE) is at the forefront where it is addressed by the National Renewable Energy Policy and Action Plan with the vision of "enhancing the utilization of indigenous renewable energy resources to contribute towards national electricity supply security and sustainable socio-economic development". The adoption of RE technology is also supported by the National Green Technology Policy (2009) aimed at providing a conducive environment for the development of green technology to become one of the economic drivers in the country.

RE can be categorized into several types of energy sources, such as solar, biogas, biomass or hydro. Through intensive research, development and research to discover new technologies to generate energy is needed. However, the use of these renewable energy resources requires time and evaluation from various aspects such as technical and maintenance aspects as well as consumer willingness to use them.

The development of SELReC PSAS using RE Solar has been designed and implemented to achieve the reduction of carbon emission levels while reducing energy costs.

2. LITERATURE REVIEW

Higher education institutions in Malaysia such as universities and polytechnics play an important role in reducing energy consumption at their institutions. Through the implementation of the green campus policy as outlined in the Polygreen Blueprint document (Malaysian Polytechnic POLYGreen Blueprint, 2015), PSAS developed a mini solar farm at Sustainable Energy Lake Recreation Center (SELReC). The action taken by PSAS to develop this 1kW small scale mini solar farm are in line with government policy. However, attention should be focused on the development

cost of this mini solar farm project as systems that use Off-Grid solar typically involve high initial costs (Kristiawan et al., 2018).

Po-Chien Hsu et al. (2017) conducted research on solar photovoltaic (PV) system for self-consumption at National Taiwan University where the system not connected to grid system. The authors mention the energy generation efficiency quite lower due to unbalance between variations of solar radiation and storage capacity (battery). Elieser Tarigan (2018) conducted the analysis of the rooftop PV at university of Surabaya, Indonesia. Through the installation of rooftop solar PV at their building, the author also to calculate greenhouse gas emission (CO2) reduction.

Normally, a solar farm is designed as an alternative to producing electricity and it will for sale to TNB through export the energy into grid system. However, solar farms in Malaysia usually sell electricity to the grid and this solar industry cover 67% of the 270MW of renewable energy (Solar Vest, 2018). However, the mini solar farm is standalone and not connected into grid. Based on the literature review, this paper present the calculation of energy cost efficiency for a mini solar farm at Sustainable Energy Lake Recreation Center (SELReC) PSAS. This paper also has been calculating the carbon emission reduction when solar PV is installed as a source to supply power for lighting at SELReC.

3. METHODOLOGY

3.1 Description of Solar PV System

Implementation of the SELReC PSAS development using solar energy involves equipment such as 720W monocrystalline photovotoic panel, 12 / 24V charger controller, 3000W inverter and 12V 330Ah battery sealed lead acid 12V 330Ah used to operate 20 units of 10W and 20W flood light. The systems operated in two conditions, day and night. During the daytime operation focuses on the absorption of ultra violet light sources by solar panel photovoltaic for the purpose of storing electricity to the battery. At night the system will operate to distribute electricity to the flood light load through the inverter.

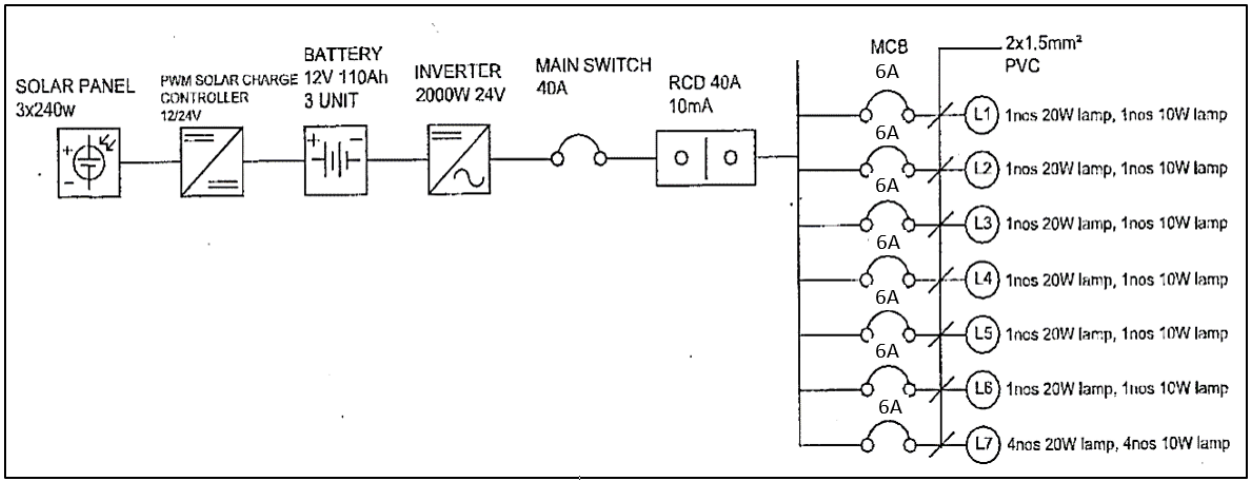

Figure 1: Single Line Diagram for SELReC PSAS

4. RESULT AND DISCUSSION

4.1. Energy Cost Efficiency Analysis

Discussion focus on the potential of carbon reduction through the reduction of the use of electricity generated by fossil fuel to zero level and determine the energy cost saving by applying the solar system by adopting the case study sample of mini solar farm at Sustainable Energy Lake Recreation Center (SELReC) PSAS.

Ideally, solar PV system at SELReC produce 881.280 kWh per year which not using any fossil electricity generation based instead used solar energy source. Power generation of a solar panel are given in Watt which to calculate the energy supplied to the battery. For the SELReC solar system used 720 Watt panel in 4 hours of sunshine, the calculation shown below (Cool Australia, 2013):

720 Watt x 3.3-hour x 0.85 x 30 days = 60.588 kWh/month.

60.588 kWh is the amount of energy produced by solar PV panel can be supplied to the battery in a month and 727.056 kWh in a year. For simplicity, the generated power does not represent any real inefficiencies, degradations and losses. For additional, the 3.3 hours of sunshine is based on Peak Sun Hour (PSH) on the average hour solar radiation at a certain location receives 1000 watts per square meter throughout the day which usually 3.3 hours (start from 10 am**)** as shown in Figure 2 (Cool Australia, 2013; My Solar Power, 2019).

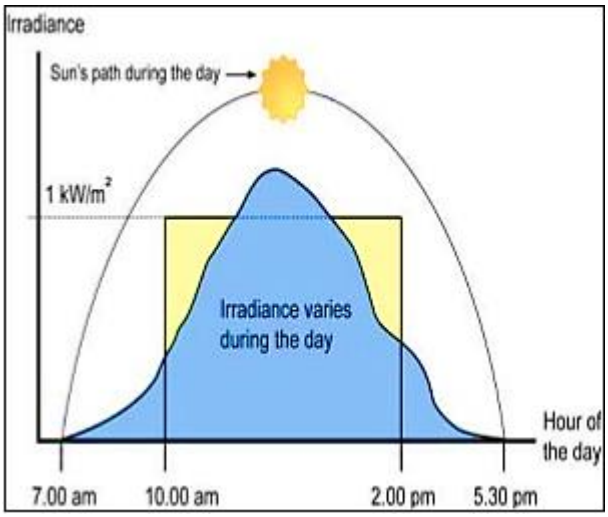

Figure 2: Peak Sun Hour (PSH)

The total energy cost on the perspective of electricity can be obtained in Table 1. The calculation of energy cost efficiency refers to the latest tariff rates issued by TNB in 2018. As an educational building, PSAS under tariff category C1 and refer medium voltage general commercial tariff. Based on this tariff for all kWh per month, the charge rate is RM0.365/kWh (Pricing & Tariff Tenaga Nasional Berhad, 2019).

Table 1: Saving of Energy Cost per Year Based on C1 Tariff Schedule

Tariff block	**Charge unit (kWh)**	**Rate (RM)**	**Total Energy Cost Saving (RM)**
Energy Consumption-Commercial C1	727.056	0.365	265.38
Total electricity bills (RM)			**265.38**

4.2. Carbon Emission Reduction

Gases that trap heat in the atmosphere are called greenhouse gases. The calculation below provides information on the potential of carbon emission or amount of potential Greenhouse Gases (GHG) (Cool Australia, 2013) emission which has been eliminated due to the development of SELReC's mini PV solar farm.

Electricity energy generated by Mini Solar Farm = 727.056 kWh/year

GHG = Electricity energy generated by Mini Solar Farm x Emission Factor (EF)

= 727.056 kWh x 0.694
= 504.576 kg CO_2
= 0.504576 tonne CO_2

5. CONCLUSION

The SELReC was developed using solar energy which provide sustainable eco system has an impact on the awareness and level of engagement of its citizens to ensure that the importance of sustainability within the PSAS campus can be expand and effectively managed. As electricity is a requirement in everyday life, the return to renewables energy will help mitigate the climate change is a good way but need to be efficiently used and managed to ensure a sustainable future for future generation.

The study brought to light the opportunities associated with SELReC mini solar farm on the aspect of energy cost saving and the amount of carbon emissions that can be avoided. It can be shown that the energy cost savings achieved is RM265.38 per year based on the amount of electricity generated through solar without the use of fossil-based electricity. In addition, the value of the carbon emission preventable from the SELReC solar mini development area is 504.576 kg of CO2.

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A STUDY ON THE SUITABILITY OF TRANSFORMER TRAINER KIT USE FOR ELECTRICAL CIRCUIT COURSE (DET2033): A COMPARISON BETWEEN THE PRACTICAL VALUE AND THEORETICAL VALUE

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ABSTRACT

The Transformer Trainer Kit is consisting of power transformer with suitable power switch, fuse, and indicator, connecting terminals etc. This product was combined of 3 types of transformer which are step-up, step-down and center tap transformer. In this paper, a study was done on the comparison between practical values and theoretical values for each of transformer type. The value of Primary Voltage, Vp, Secondary Voltage,Vs, Primary Current, Ip and Secondary Current, Is was measured and calculated in the experiment. As a result, there are small differences between practical and theoretically current where the range of accuracy percentage is between 83%-99% for Vp,Vs and Is. It is shows that the Transformer Trainer Kit is suitable to use in learning process and fulfilling the course work requirement in polytechnic syllabus especially course Electrical Circuit (DET2033).

KEYWORDS: *Transformer Trainer Kit, practical value, theoretical value.*

1. INTRODUCTION

A transformer is a static device consisting of a winding, or two or more coupled windings, with or without a magnetic core, for inducing mutual coupling between circuits. Transformers are exclusively used in electric power systems to transfer power by electromagnetic induction between circuits at the same frequency, usually with changed values of voltage and current. (John J. Winders, Jr, 2002). The Voltage Transformer can be thought of as an electrical component rather than an electronic component.

There are two types of transformers, namely: Step down and Step up transformers. Generally, the difference between them is the amount of voltage produced, depending on the number of secondary coils.

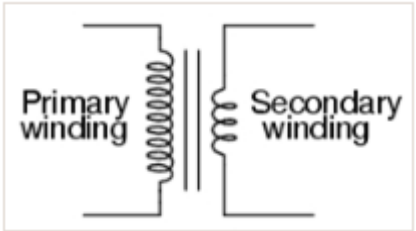

Figure 1: Step down Transformer

In a step-down transformer is one who secondary windings are fewer than the primary windings. In other words, the transformer's secondary voltage is less than the primary voltage. So, the transformer is designed to convert high-voltage, low-current power into a low-voltage, high current power and it is mainly used in domestic consumption.

A common case of step-down application is in the case of door bells. Normally, door bells use 16 volts, but most household power circuits carry 110-120 volts. Therefore, the doorbell's step-down transformer receives the 110 volts and reduces it to lower voltage before supplying it to the doorbell.

Step-down transformers are mostly used to convert the 220 volts electricity to the 110 volts required in most domestic equipment.

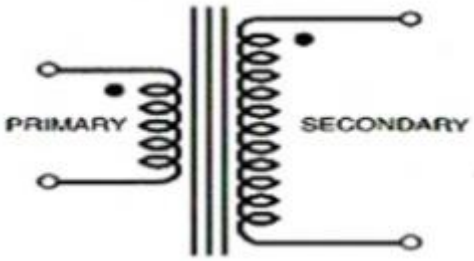

Figure 2: Step up Transformer

A step-up transformer is the direct opposite of a step-down transformer. There are many turns on the secondary winding than in the primary winding in the step-up transformers. Thus, the voltage supplied in the secondary transformer is greater than the one supplied across the primary winding. Because of the principle of conservation of energy, the transformer converts low voltage, high-current to high voltage-low current. In other words, the voltage has been stepped up.

2. METHODOLOGY

This part will discuss about the design of the project which includes the flow chart, panel design, circuit design and the operation of the Transformer Trainer Kit.

a) Flow chart.

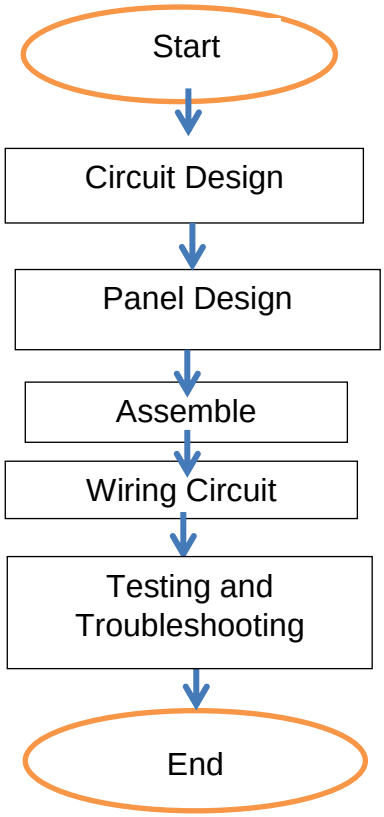

Figure 1: Process to prepare the Transformer Trainer Kit

b) Panel design

The panel design at the front of the project is used to facilitate the user to connect the circuit. It is shows the circuit layout in the Transformer Trainer Kit. The iron box is used as a casing with other components such as on / off button, female banana jack socket (black), female banana jack socket (red), female banana jack socket

(blue), some resistors value, green neon indicator as indicator and selector as selector button. Figure 2 shows the front panel of the Trainer.

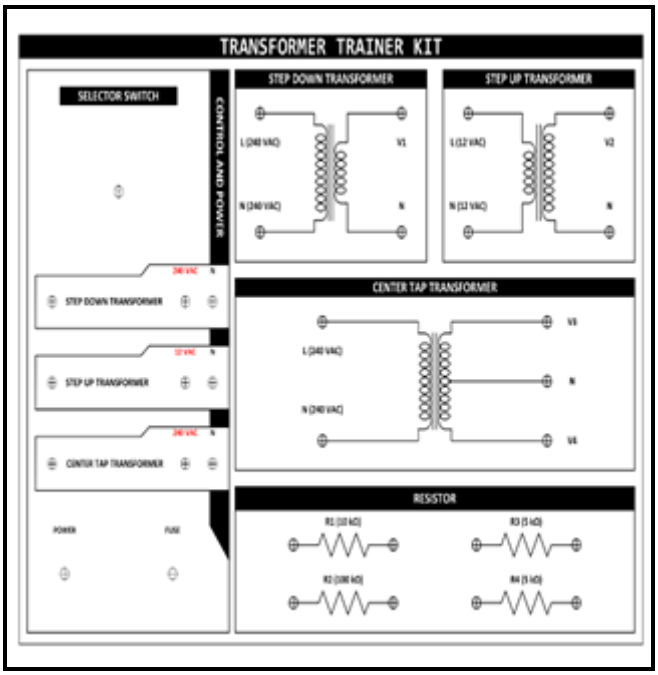

Figure 2: Front panel for Transformer Trainer Kit.

The selector is used to select the connection before doing the experiment. The selector button comes with a green neon indicator as an indicator for the user to determine which circuit is working at that moment. This is easy for users to identify the circuit as well as to make proper circuit connections during the experiment. The trainer is also equipped with security features using fuse.

a) The operation of *Transformer Trainer Kit*

i) Transformer Trainer Kit Circuit consists of 3 main parts which are step-up connection, step-down connection and center-tap connection. There is also a load section consisting of several types of resistor values.
ii) Further discussion about circuit's connections and the result will be discussed in result and discussion part.

3. RESULTS AND DISCUSSIONS

The transformers that are used is having between 100 and 500 windings, which can be combined in different ways. Each winding has a reference dot to define its polarity (the polarity is actually defined by the direction of the windings around the core – clockwise or counterclockwise).

The relationship between voltages and currents in a transformer are given by the following equations as been wrote by (John Bird, 2010)

$$\frac{N_1}{N_2} = \frac{V_1}{V_2} = \frac{I_2}{I_1} \qquad ; I_2 = \frac{V_2}{R_L}$$

The percentage of accuracy also was calculated by using the equation below;

$$\% \text{ Accracy} = 1 - \left| \frac{\text{Calculated value} - \text{Measurement value}}{\text{Calculated value}} \right| \times 100$$

To get the measurement value, an experiment was done by using Transformer Trainer Kit.

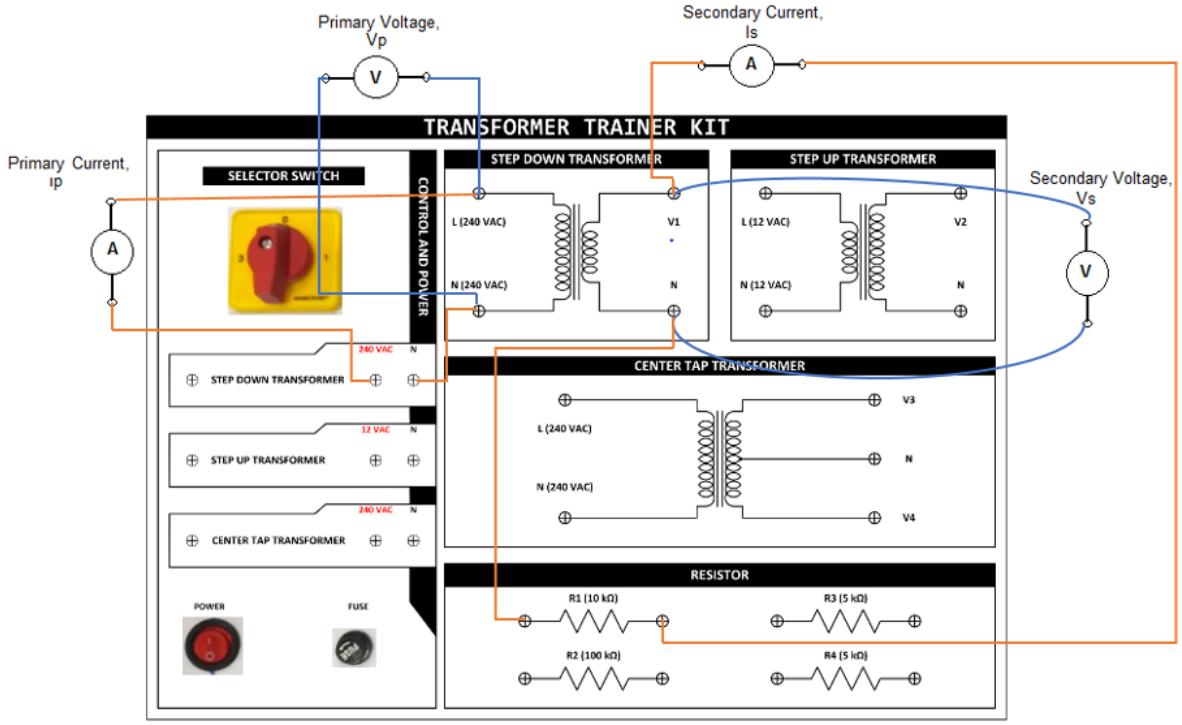

Figure 3: Step-Down Transformer Connection

Figure 1 shows Step-Down Transformer connection on Transformer Trainer Kit. AC power supply switch was turned on and the selector was turned to '1'. The lamp indicator at step-down transformer will turn on. Primary rms voltage, V_P,Secondary rms voltage,V_S, and Secondary rms current, I_S was measured using voltmeter and ammeter. Then, all the measured values was recorded in Table 1 as shown below.

Table 1

No	Parameter	Measured Value	Calculated Value	% Accuracy
1	Primary voltage, Vp	242.4 V	240V	99%
2	Secondary Voltage, Vs	14.15 V	12.52V	87%
3	Secondary current, Is	1.4 mA	1.3mA	92%
4	Turn ratio, ŋ	242.2/14.15	230/12	

The selector was turned to '0' to turn off the AC power supply. The value of V_P, V_S, and I_S was calculated using the formula below; (John Bird, 2010)

$$\frac{N_1}{N_2} = \frac{V_1}{V_2} = \frac{I_2}{I_1} \qquad ; I_2 = \frac{V_2}{R_L}$$

All the calculated value was recorded in Table 1.

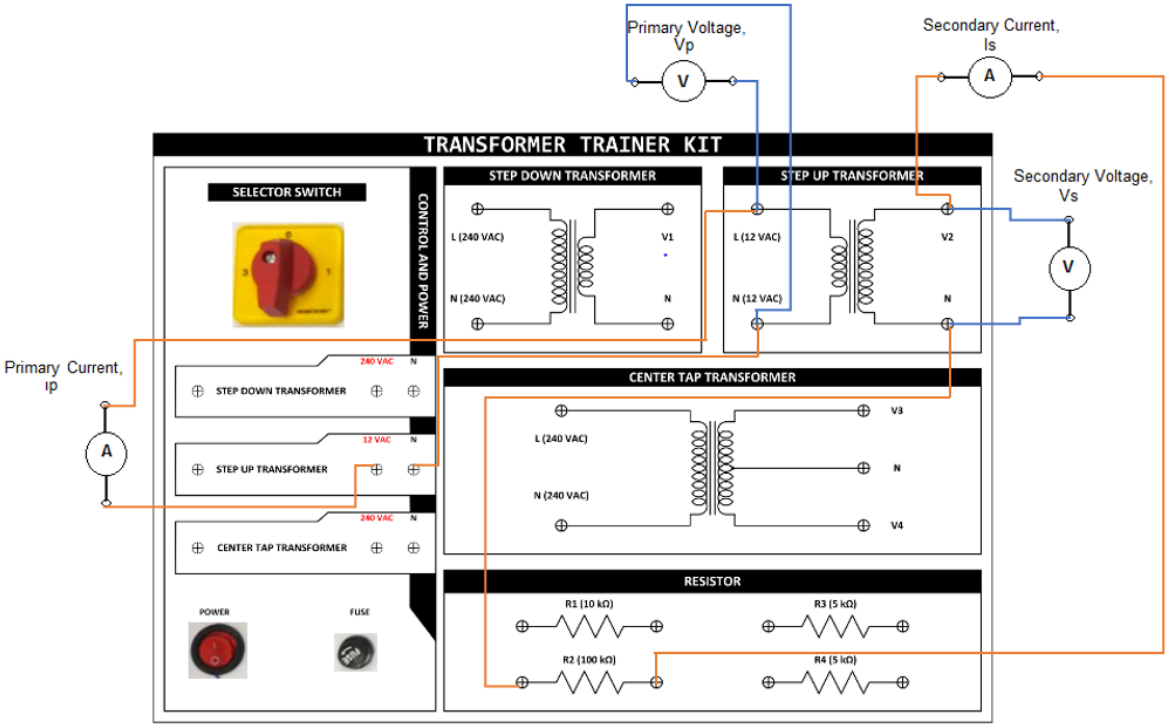

Figure 4: Step-Up Transformer Connection

Connection for experiment of Step-Up Transformer is shown in Figure 2. AC power supply switch was turned on and selector was turned to '2'. The lamp indicator at Step-Up Transformer will turn on. Primary rms voltage, V_P,Secondary rms voltage,V_S, and Secondary rms current, I_S was measured using voltmeter and ammeter. Then, all the measured values was recorded in Table 2 as shown below;

Table 2

No	Parameter	Measured Value	Calculated Value	% Accuracy
1	Primary voltage, Vp	12.2 V	12V	98%
2	Secondary Voltage, Vs	224 V	230V	97%
3	Secondary current, Is	2.1m A	2.3mA	91%
4	Ratio, η	12.2/224	12/230	

The selector was turned to '0' to turn off the AC power supply. The value of V_P,V_S, and I_S was calculated using the formula below; (John Bird, 2010)

$$\frac{N_1}{N_2} = \frac{V_1}{V_2} = \frac{I_2}{I_1} \qquad ; I_2 = \frac{V_2}{R_L}$$

All the calculated value was recorded in Table 2.

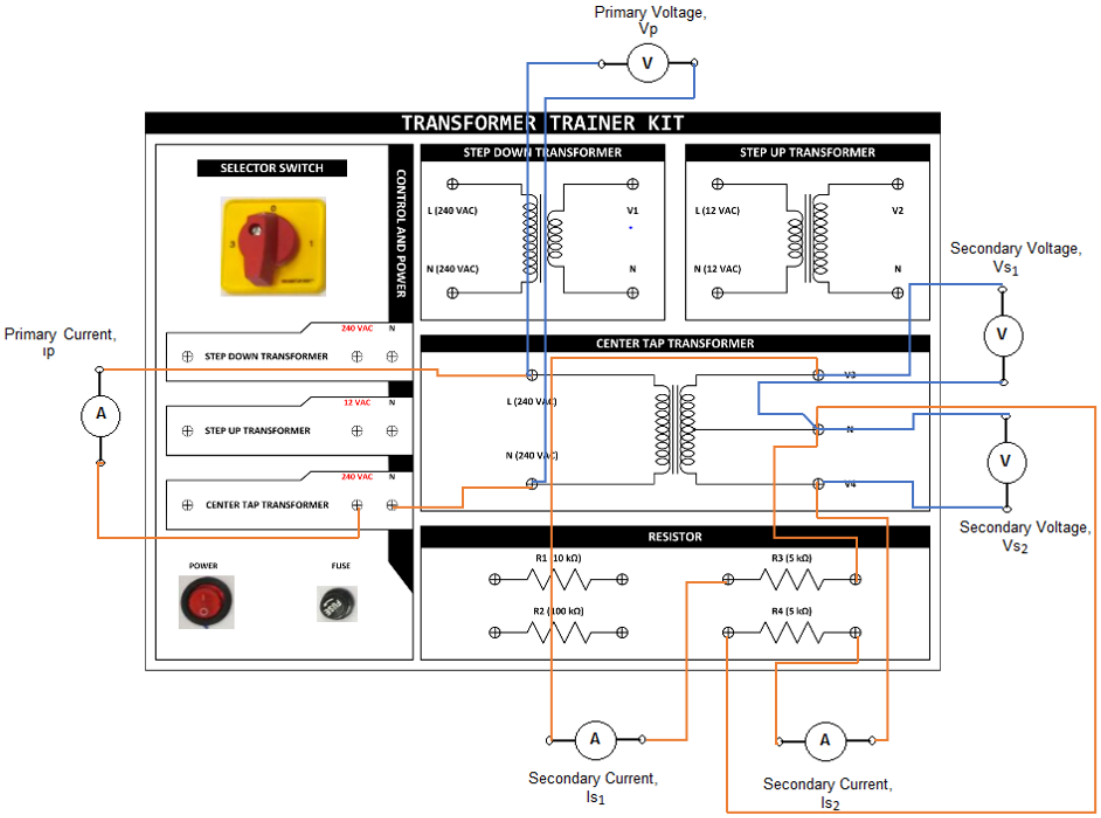

Figure 3 Center Tap Transformer Connection

Figure 3 shows Center Tap Transformer connection on Transformer Trainer Kit. AC power supply switch was turned on and the selector was turned to '3'. The lamp indicator at Center Tap transformer will turn on. Primary rms voltage, V_P,Secondary rms voltage,V_S, and Secondary rms current, I_S was measured using voltmeter and ammeter. Then, all the measured values was recorded in Table 3 as shown below;

Table 3

No	Parameter	Measured Value	Calculated Value	% Accuracy
1	Primary voltage, Vp	242.4 V	240V	99%
2	Secondary Voltage 1, Vs_1	Vs_1= 7V ,	Vs_1= 6V	83%
3	Secondary Voltage 2, Vs_2	Vs_2 = 7V	Vs_2 = 6V	83%
4	Secondary current 1, Is_1	Is_1= 1.3mA	Is_1= 1.2mA	92%
5	Secondary current 2, Is_2	Is_2 = 1.3 mA	Is_2 = 1.2mA	92%
6	Ratio, η	242/7-0-7	230/6-0-6	

The selector was turned to '0' to turn off the AC power supply. The value of V_P,V_S, and I_S was calculated using the formula below; (John Bird, 2010)

$$\frac{N_1}{N_2} = \frac{V_1}{V_2} = \frac{I_2}{I_1} \qquad ; I_2 = \frac{V_2}{R_L}$$

All the calculated value was recorded in Table 3.

4. CONCLUSION AND RECOMMENDATION

This research paper has shown that the application of Transformer Trainer Kit is suitable to use in learning process and fulfilling the course work requirement in polytechnic syllabus especially course Electrical Circuit (DET2033). This trainer is effective trainer for students to do the hands-on concept of learning. Besides, the percentage of accuracy between calculation value and measurement value still in acceptable range.

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KAJIAN TERHADAP PENGGUNAAN SISA SERBUK GETAH DALAM PENGHASILAN "INTERLOCKING PAVEMENT BLOCK"

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ABSTRAK

Tayar terpakai merupakan salah satu daripada bahan buangan yang terbesar dan paling bermasalah di negara kita Malaysia Tanpa sistem pelupusan yang sistematik, tayar yang telah digunakan akan berakhir dengan dibuang sewenang-wenangnya di merata tempat dan mewujudkan tempat pembiakan nyamuk dan masalah pembakaran terbuka. Kajian dilakukan bagi menghasilkan blok turapan pejalan kaki yang diberi nama 'Rubber Tyre Waste Interlocking Pavement Block'. Bahan yang digunakan adalah simen, aggregat halus (pasir), serbuk tayar getah dan air. Saiz sisa tayar getah yang digunakan untuk kajian ini ialah 3 - 5 mm. Saiz sampel kotak acuan untuk sampel ujian adalah 50 mm x 50 mm x 50 mm. Nisbah yang digunakan ialah 1:3 iaitu nisbah simen kepada nisbah pasir dan 0%, 5%, 10%, 15%, 20% sisa tayar getah digunakan sebagai pengganti aggregat halus bagi setiap nisbah sampel. Perbandingan kekuatan dan kadar resapan air antara 'interlocking block' biasa (0% serbuk tayar getah) dan 'interlocking block' yang menggunakan serbuk getah mengikut nisbah dilakukan dengan menjalankan ujian makmal. Daripada ujian makmal , di dapati ujian mampatan bagi campuran nisbah 5%, 10% dan 15% serbuk getah memberikan nilai yang rendah tetapi masih lagi tergolong di dalam kelas blok 'load bearing' iaitu kelas 1 (piawaian (BS EN 772 / BS 4551) dan bagi ujian resapan air, di dapati, semua peratusan serbuk getah adalah sesuai digunakan dan mengikut piawaian yang ditetapkan BS EN 772 / BS 4551. Peratusan serbuk getah yang terbaik untuk pembuatan 'interlocking block' adalah sebanyak 5% disebabkan bacaan ujian mampatan yang paling tinggi antara nisbah yang lain iaitu 12.8MN/m^2.

KATA KUNCI: *'interlocking block', serbuk tayar getah, ujian mampatan, ujian resapan air*

1. PENGENALAN

Perkembangan dalam sektor pembinaan merupakan salah satu faktor yang menyumbang kepada kemajuan dan juga peningkatan ekonomi kepada sesebuah negara. Pada zaman yang semakin berkembang pesat ini, teknologi juga berubah dan semakin berkembang lantaran kepada keperluan perkembangan dalam bidang teknologi, ekonomi dan sosial. Perkembangan dalam dunia teknologi adalah menjadi keutamaan kepada sesebuah negara kerana ianya bertindak sebagai pemangkin kepada pusat perubahan ekonomi, sosial dan masyarakat. Oleh itu, kajian terhadap penggunaan sisa serbuk getah dalam penghasilan 'interlocking pavement block' dilakukan disebabkan oleh pertambahan lambakan sisa tayar dan masalah yang disebabkan olehnya yang menjadi isu utama yang sering diperkatakan di media massa. Ini kerana, lambakan tayar yang dibuang menyebabkan pelbagai masalah diantaranya adalah masalah kesihatan. Ianya adalah kerana tayar yang dibuang dengan cara yang tidak sepatutnya menjadi tempat takungan nyamuk aedes yang menyebabkan penularan penyakit demam denggi. Seterusnya, cara pelupusan tayar yang salah iaitu pembakaran secara terbuka dan akan menyebabkan pencemaran udara. Tayar yang dibakar menghasilkan asap yang boleh menyebabkan penyakit kanser yang boleh menyebabkan maut. Pembuangan sisa tayar secara berleluasa menyebabkan peningkatan tempat pembiakan nyamuk Aedes dan peningkatan kes kematian yang disebabkan oleh nyamuk Aedes di Malaysia. Kes kebakaran yang disebabkan oleh tayar yang berlaku di Virginia, Amerika Syarikat pada tahun 1983 mencatatkan tahap bacaan maksimum kebakaran iaitu kepulan asap hitam naik 3000 kaki ke udara dan merebak di bawah tiupan angin sehingga 80 kilometer (km) dan terbakar selama sembilan bulan lamanya. Ianya menjadi salah satu kebakaran tayar yang paling teruk dalam sejarah. (Agnes Tugong, Utusan Borneo Online pada 23 April 2015)

2. SOROTAN KAJIAN

'Interlocking block' adalah bata yang direka untuk dicantumkan antara satu sama yang lain dengan mudah. Terdapat dua jenis 'interlocking block' berdasarkan bahan yang digunakan semasa pembinaan iaitu 'interlocking block' simen pasir dan 'interlocking block' konkrit. Nisbah pasir kepada simen untuk 'interlocking block' simen pasir adalah dalam nisbah antara 1:6 kepada 1:10. Nisbah simen,pasir dan batu kerikir untuk 'interlocking block'

konkrit 1:5:3. Sistem 'interlocking block' yang digunapakai di dalam pembinaan mempunyai pelbagai kelebihan antaranya efisien dan menjimatkan masa pembinaan, menjimatkan kos di dalam pembinaan, rekabentuk seni bina yang menarik dan menyeragamkan rekabentuk. Di dalam kajian ini, nisbah simen kepada agregat halus yang digunakan adalah 1:3, 1:6 dan 1:8. Peratusan serbuk tayar getah yang digunakan untuk menggantikan agregat (pasir) adalah sebanyak 5%,10%,15% dan 20%. Kemudian, 'interlocking block' yang telah dicampurkan dengan sisa tayar getah mengikut peratusan dibandingkan dengan 'interlocking block'yang tidak menggunakan serbuk tayar getah dengan membuat ujian terhadap sampel produk. Ujian yang dilakukan adalah ujian kekuatan mampatan (compressive strength) dan ujian resapan air (water absorption). Ujian-ujian yang dilakukan adalah dengan mengikut piawaian BS EN 1338 : 2013.

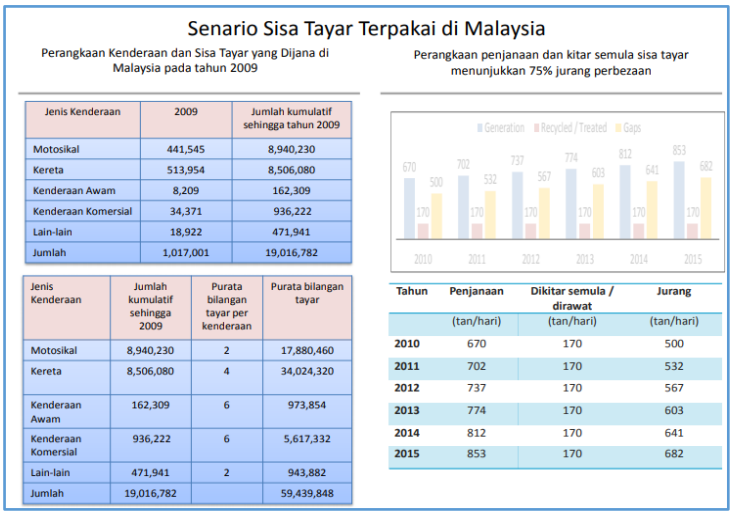
2.1 Getah

Getah adalah sejenis bahan yang unik yang mempunyai sifat fizikal yang elastik dan likat. Ia juga berfungsi sebagai penebat arus elektrik dan gegaran yang baik. Terdapat dua jenis getah iaitu getah asli dan getah sintetik . Getah asli dihasilkan daripada lateks pokok Hevea Brasiliensis, sumber asli isoprena yang lebih dikenali sebagai "india rubber" dimana ia dikeringkan untuk proses komersial. Getah asli mempunyai kedua-dua sifat elastik dan likat mejadikan ia polimer yang ideal dalam pengaplikasian kejuruteraan yang dinamik dan statik. Kelebihan getah asli berbanding getah sintektik adalah ia mempunyai kepuasan dinamik yang lebih bagus, tahap rendaman yang lebih rendah, dan sifat rintangan yang lebih tinggi terhadap kekoyakkan ketika panas.

Manakala, getah sintetik pula dihasilkan dengan menggunakan teknik larutan atau emulsi pempolimeran. Apabila mengaplikasikan teknik polimer kimia, dapat memberi peluang yang lebih hebat dalam menghasilkan getah yang mempunyai sifat mekanikal seperti sifat perintang api, kimia dan larutan yang lebih tinggi daripada getah asli. Terdapat lebih daripada 20 jenis getah sintetik yang mempunyai sifat mekanikal yang berlainan mengikut kehendak dan situasi. Kelebihan getah sintetik berbanding getah asli ialah sifat rintangan terhadap minyak, bahan kimia dan oksigen yang lebih bagus. Sifat rintangan terhadap penuaan dan luluhawa yang lebih bagus. Daya tahan yang lebih tinggi terhadap haba dalam jarak yang lebih tinggi. (Ronald J. Schaefer , Chapter 33 Mechanical Properties Of Rubber, 2002).

2.2 Permasalahan Pembuangan Sisa Tayar Getah

Masalah pembuangan sisa tayar getah semakin berleluasa sejak kebelakangan ini. Menurut sebuah artikel dari Berita Harian Online (Faris Fuad,2018) yang menunjukkan satu kes pembuangan tayar terpakai yang menjadi tempat tangkungan air dan seterusnya menjadi sarang pembiakan nyamuk Aedes. Manakala sebuah artikel dari Utusan Borneo Online (Agnes Tugong,2015) rajah 1 yang menunjukkan mengenai peningkatan kadar purata kenderaan yang didaftarkan setiap tahun di Malaysia. Ianya menyumbang kepada peningkatan pembuangan tayar kenderaan kerana tayar kenderaan perlu ditukar setiap tahun.



Senario Sisa Tayar Terpakai di Malaysia

Perangkaan Kenderaan dan Sisa Tayar yang Dijana di Malaysia pada tahun 2009

Jenis Kenderaan	2009	Jumlah kumulatif sehingga tahun 2009
Motosikal	441,545	8,940,230
Kereta	513,954	8,506,080
Kenderaan Awam	8,209	162,309
Kenderaan Komersial	34,371	936,222
Lain-lain	18,922	471,941
Jumlah	1,017,001	19,016,782

Jenis Kenderaan	Jumlah kumulatif sehingga 2009	Purata bilangan tayar per kenderaan	Purata bilangan tayar
Motosikal	8,940,230	2	17,880,460
Kereta	8,506,080	4	34,024,320
Kenderaan Awam	162,309	6	973,854
Kenderaan Komersial	936,222	6	5,617,332
Lain-lain	471,941	2	943,882
Jumlah	19,016,782		59,439,848

Perangkaan penjanaan dan kitar semula sisa tayar menunjukkan 75% jurang perbezaan

Tahun	Penjanaan (tan/hari)	Dikitar semula / dirawat (tan/hari)	Jurang (tan/hari)
2010	670	170	500
2011	702	170	532
2012	737	170	567
2013	774	170	603
2014	812	170	641
2015	853	170	682

Rajah 1: Senario sisa tayar terpakai

2.3 Bahan pembuatan 'interlocking block'

Kajian ini bermula dengan penyediaan bahan-bahan yang akan digunakan untuk menghasilkan 'interlocking block'. Bahan utama yang diperlukan ialah simen, aggregate halus (pasir), air dan getah. Ujian kekuatan mampatan dan ujian resapan air dilakukan ke atas 'interlocking block' .

2.3.1 Simen
Simen yang digunakan di dalam pembinaan mestilah simen yang didapati daripada pembuat simen SIRIM (Standard and Industrial Research Institute of Malaysia). Simen yang digunakan juga mesti mematuhi garis panduan MS EN 197-1.

2.3.2 Agregat halus (pasir)
Agregat terbentuk dari pasir secara semulajadi , granit atau batu kapur. Kesemua agregat tersebut hendaklah mematuhi MS EN 12620. Agregat yang digunakan juga mestilah daripada sumber-sumber yang dibenarkan. Agregat terdiri daripada dua jenis iaitu agregat kasar dan agregat halus. Di dalam konteks MS EN 12620, istilah 'pasir' digunakan untuk menggantikan 'agregat halus'. Ujian yang dilakukan mesti memenuhi dan mengikuti MS 30. Pasir halus yang digunakan di dalam pembuatan produk 'interlocking block' adalah pasir halus yang telah diayak terlebih dahulu dan diperolehi di tapak pembekal pasir di Puchong, Selangor seperti di dalam rajah 2.

Rajah Error! No text of specified style in document.**: Pasir halus**

2.3.3 Air
Air yang digunakan mestilah memenuhi MS EN 1008. Ia mesti bersih dan terhindar daripada bahan-bahan yang boleh merosakkan konkrit di dalam keadaan plastik dan keras.

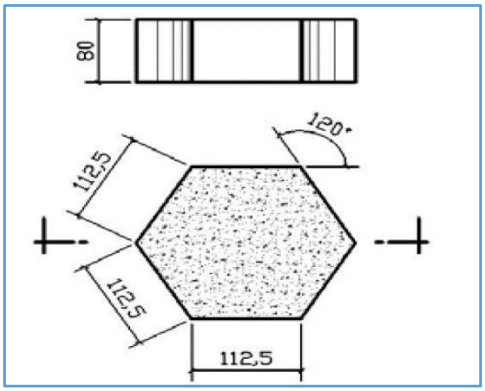
2.3.4 Getah
Bahan sisa getah tayar, seperti di rajah 3 diperolehi di sebuah kilang di Kedah,Malaysia yang beralamat Gcycle Company,30&31, Jalan Industri 1/4 Kaw. Perusahaan Ringan Desa Aman, Sungai Lalang, Kampung Pengkalan Batu, 08100 Bedong, Kedah yang bersaiz 3-5mm. Saiz tayar yang telah dicarikkan yang terdapat di kilang tersebut adalah 1mm-3mm, 3mm-5mm, 5mm-7mm, 20 mesh dan 30 mesh.

Rajah 3: Sisa tayar yang telah dihancurkan

3. METODOLOGI KAJIAN

'Interlocking block' yang dihasilkan menggunakan serpihan getah, aggregate halus dan simen. Saiz ketebalan yang digunakan adalah 80 milimeter (mm) dan kelebaran sisi setiap permukaan adalah 112.5 milimeter (mm) dibuat menggunakan campuran sisa tayar getah. Pemilihan saiz dan dimensi bata dibuat berpandukan 'General

spefication dimensions and tolerances for brick guided by MS 7.6: 1972 / British Standard BS 3921: 1985'. Nisbah yang digunakan adalah 1:3 iaitu nisbah simen kepada pasir kerana untuk sampel nisbah 1:6 dan 1:8 nilai ujian kekuatan sampel tidak diperolehi.. Kuantiti air yang digunakan adalah separuh daripada berat simen. Peratusan getah yang digunakan adalah 5%,10%,15% dan 20% daripada berat pasir.



Rajah 4: Rekabentuk 'interlocking block'

(Dimensions & Tolerances)

Specified Dimensions	Overall Measurement of 24 Bricks
Height: 65 + 1.875 mm	1560 + 45 mm
Width: 102.5 + 1.875 mm	2460 + 45 mm
Length: 215 + 3 mm	5160 + 75

3.1 Proses penghasilan 'interlocking block'

Proses pengiraan bahan mengikut nisbah 1:3 iaitu nisbah simen kepada aggregate halus telah dilakukan bagi mengelakkan pembaziran sebelum proses penghasilan produk dilakukan. Antara proses yang dilakukan dalam penghasilan 'interlocking block':

i. Bahan yang telah diayak ditimbang mengikut berat tertentu
ii. Sisa tayar,getah,simen dan pasir digaul dengan mengunakan skop untuk mendapatkan sebatian yang sekata
iii. Satu lubang dibentuk ditengah campuran untuk mencampurkan air mengikut nisbah yang ditentukan
iv. Campuran bahan tersebut digaul untuk mendapatkan campuran yang sebati
v. Campuran tersebut dituang kedalam kotak acauan
vi. Campuran yang diletakkan didalam kotak acuan dimampatkan dengan rod pemadat untuk memadatkan campuran tersebut
vii. Campuran tersebut dibiarkan kering dibawah cahaya matahari selama beberapa hari.
viii. Interlocking block dikeluarkan dari kotak acuan

Rajah 5: Proses penimbangan

Rajah 6: Proses pengaulan simen, agregat (pasir), serbuk tayar getah dan air

Rajah 7: Campuran yang telah dimasukkan ke dalam kotak acuan 'interlocking block'

3.2 Pengujian

Terdapat dua jenis ujian yang dilakukan ke atas sampel. Ujian yang dilakukan adalah ujian kekuatan mampatan (compressive strength) dan ujian resapan air (water absorption)

3.2.1 Ujian Resapan Air (Water Absorption Test)

Ujian ini bertujuan mengetahui kadar peratusan resapan air bagi sesuatu konkrit. Jika sesuatu konkrit. Ujian ini berpandukan piawaian (MS 7.6: 1972 / British Standard BS 3921: 1985)

Prosedur:

i. Kiub yang telah diawet selama 7 hari dan 14 hari akan dikeluarkan dan dikering di dalam ketuhar sehingga kering dengan menggunakan suhu 105 darjah celcius

ii. Kemudian, kiub yang telah kering akan dikeluarkan daripada ketuhar dan dimasukkan kedalam bekas kedap udara selama 1 hari.
iii. Setelah sehari, kiub tersebut akan ditimbang beratnya dan kemudian direndam di dalam air selama 30 minit
iv. Setelah 30 minit, kiub tersebut akan ditimbang kembali beratnya untuk mengukur kadar serapa air.

$$kadar\ serapan\ air = \frac{berat\ selepas - berat\ sebelum}{berat\ selepas} \times 100$$

3.2.2 Ujian Kekuatan Mampatan (Compressive Strength)

Ujian ini bertujuan untuk mengetahui karakteristik konkrit. Ianya adalah untuk kita mengetahui adakah kerja mengkonkrit ini dilakukan secara betul. Selain itu, ianya juga bertujuan untuk mengetahui adakah material dapat menampung beban ke atas permukaan di bawah tekanan. Ujian ini berpandukan piawaian (MS 7.6: 1972 / British Standard BS 3921: 1985)

i. Keluarkan spesimen daripada air selepas tamat tempoh pengawetan dan singkirkan air berlebihan daripada permukaan kiub
ii. Dimensi spesimen diambil
iii. Permukaan mesin ujian dibersihkan
iv. Tempatkan spesimen ke dalam mesin ujian
v. Spesimen diselaraskan ke tengah-tengah permukaan plat mesin ujian
vi. Beban dikenakan ke atas permukaan spesimen secara berterusan sehingga spesimen mengalami kegagalan
vii. Beban maksimum direkod dan keputusan ujian diambil sebanyak 3 kali bagi setiap nisbah bagi mendapatkan purata beban

Rajah 8: Mesin mampatan

4. ANALISIS DAN KEPUTUSAN

Analisa data dilakukan bagi mengenalpasti permasalahan yang dihadapi selepas keputusan ujian dilakukan ke atas sampel produk. Berpandukan data keputusan ujian yang dilakukan ke atas sampel produk, nisbah dan peratusan terbaik dipilih dan dijadikan produk akhir 'interlocking block'.

4.1 Data ujian kekuatan mampatan

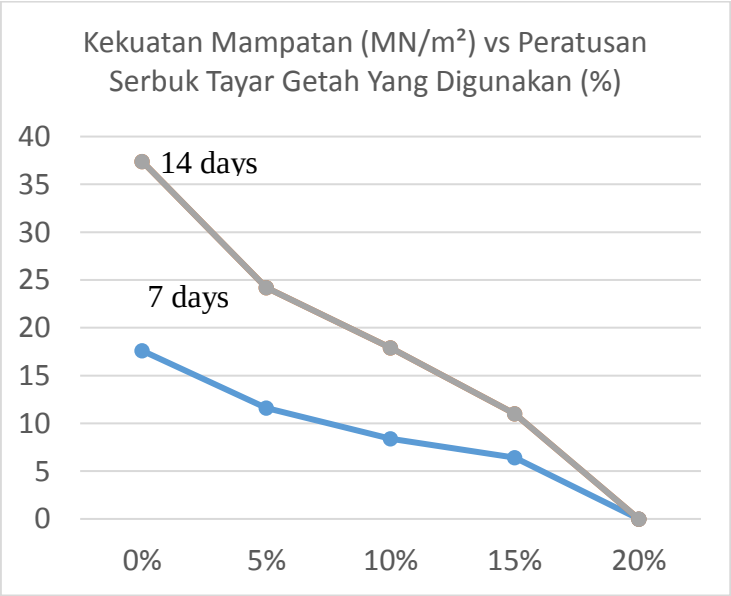
Data purata kekuatan daya mampatan bagi 7 dan 14 hari pengawetan bagi nisbah 1:3 seperti yang ditunjukkan di dalam Jadual 1.

Rajah 9 menunjukkan graf kekuatan mampatan berlawanan peratusan serbuk tayar getah yang digunakan untuk mencari peratusan serbuk tayar getah yang terbaik bagi menghasilkan 'interlocking block'. Berdasarkan graf di rajah 9, data yang terbaik bagi tempoh pengawetan 7 hari adalah 17.6 MN/m². manakala bagi tempoh pengawetan 14 hari pula, data yang terbaik adalah 19.8 MN/m². Kedua-dua data tersebut tergolong daripada 0%. Untuk pengunaan peratusan getah yang terbaik pula adalah tergolong daripada 5% iaitu 11.6 dan 12.6 bagi pengawetan pada 7 hari dan 14 hari.

Jadual 1: Daya purata mampatan

Masa pengawetan	Peratusan serbuk tayar getah yang digunakan (%)	Purata kekuatan daya mampatan (MN/m²)
7 hari	0	17.6
	5	11.6
	10	8.4
	15	6.4
	20	0.0
14 hari	0	19.8
	5	12.6
	10	9.5
	15	4.6
	20	0.0

Graf Kekuatan Mampatan (MN/m²) vs Peratusan Serbuk Tayar Getah Yang Digunakan (%)



Rajah 9: Graf Kekuatan Mampatan (MN/m²) vs Peratusan Serbuk Tayar Getah Yang Digunakan (%)

4.2 Data ujian resapan air

Data berat sebelum dan selepas direndam seperti yang ditunjukkan di jadual 2.

Jadual 2: Perbezaan berat sebelum dan selepas rendaman

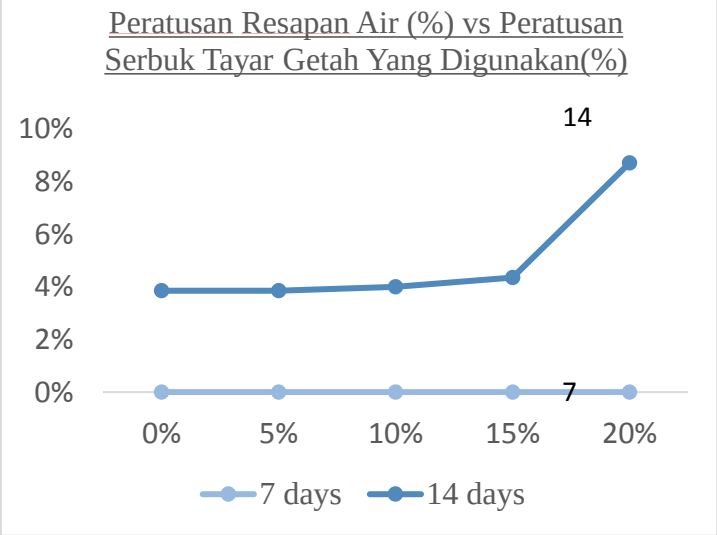
Masa pengawetan	7 hari		14 hari	
Peratusan serbuk tayar getah yang digunakan (%)	Berat sebelum direndam (gram,g)	Berat selepas direndam (gram,g)	Berat sebelum direndam (gram,g)	Berat selepas direndam (gram,g)
0	260	260	250	260
5	250	250	250	260
10	240	240	240	250
15	230	230	220	230
20	220	220	210	230

Data peratusan resapan air selama 7 dan 14 hari seperti yang ditunjukkan di jadual 3

Jadual 3: Peratusan serapan air

Peratusan serbuk tayar getah yang digunakan (%)	Peratusan resapan air, % (7 hari)	Peratusan resapan air,% (14 hari)
0	0	3.85
5	0	3.85
10	0	4.00
15	0	4.35
20	0	8.7

Graf peratusan resapan Air (%) vs peratusan serbuk tayar getah yang digunakan (%)



Rajah 10: Graf peratusan resapan air

Merujuk pada rajah 10, graf menunjukkan peratusan resapan air berlawanan peratusan serbuk tayar yang digunakan. Bagi tempoh pengawetan untuk 7 hari, kesemua nisbah memilik kadar peratusan resapan air sebanyak 0%. Manakala, bagi tempoh pengawetan untuk 14 hari, kadar peratusan resapan air terbanyak adalah 20% iaitu sebanyak 8.7%. Manakala kadar peratusan resapan air yang terendah adalah 0% dan 5% iaitu 3.85 %.

5. KESIMPULAN

Hasil analisa kajian ujian kekuatan mampatan, didapati bahawa sampel 0% hingga 15% bagi nisbah 1:3 adalah tergolong di dalam kelas blok 'load bearing' dan sampel 0% adalah di dalam kelas 3, sampel 5% adalah di dalam kelas 2 dan sampel 10% serta 15% tergolong di dalam kelas 1.Manakala bagi sampel 20%, ianya tergolong di dalam kelas 'damp proof course'.

Manakala bagi ujian resapan air, nisbah keseluruhan sampel adalah mengikuti piawaian yang ditetapkan dan mempunyai nilai kadar peratusan resapan yang rendah. Namun begitu, nilai yang paling tinggi dicatatkan adalah daripada sampel yang menggunakan peratusan getah sebanyak 20 % dan mempunyai kadar peratusan resapan air sebanyak 8.7% . Oleh yang demikian., nisbah 5% serbuk tayar getah yang menggantikan agregat halus untuk dijadikan 'interlocking block' adalah bersesuaian.

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PENGGUNAAN *SPENT BLEACHING EARTH* DARI SISA PEPEJAL KELAPA SAWIT DALAM REKABENTUK BANCUHAN KONKRIT

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ABSTRAK

Spent Bleaching Earth (SBE) merupakan sisa industri yang dihasilkan daripada proses pemurnian minyak kelapa sawit. *Environmental Treated Clay* (ETC) diperoleh daripada pengekstrakan *hexane* daripada *Spent Bleaching Earth* (SBE). Masalah pembuangan sisa industri minyak kelapa sawit yang berlebihan dapat dikurangkan dengan menggantikan ETC ke dalam bahan konkrit. Kajian ini bertujuan mengkaji ETC sebagai bahan alternatif dalam konkrit. Kajian dijalankan dengan menggantikan simen dengan 20% ETC dan 30% ETC serta menggantikan pasir dengan 50% ETC dan 60% ETC. Sebanyak 45 kiub sampel bersaiz 150mm x 150mm x150mm disediakan dengan nisbah bahan bancuhan yang berbeza-beza. Pengawetan air dipraktikkan keatas sampel kiub yang dihasilkan. Ujian kekuatan mampatan telah dijalankan keatas konkrit yang berumur 7 hari, 14 hari dan 28 hari. Perbandingan keputusan ujian kekuatan mampatan kiub menunjukkan bahawa konkrit yang menggantikan simen dengan 20% ETC mempunyai kekuatan lebih tinggi berbanding dengan 30% ETC. Manakala konkrit yang menggantikan pasir dengan 50% ETC mempunyai kekuatan lebih tinggi berbanding dengan 60% ETC. Dapatan menunjukkan pertambahan peratusan ETC dalam bancuhan konkrit menggantikan simen dan pasir akan menyebabkan penurunan nilai kekuatan mampatan konkrit tersebut. Dapatan menunjukkan peratusan ETC sebagai bahan gantian perlu dikurangkan untuk memastikan konkrit mencapai kekuatan mampatan yang tertentu. Kajian ini menunjukkan ETC sebagai pilihan bahan baru dalam pasaran semasa untuk persekitaran yang lebih hijau.

KATA KUNCI: *Spent Bleaching Earth* (SBE), *Environmental Treated Clay* (ETC)

1.0 PENGENALAN

Konkrit merupakan sejenis bahan komposit yang sering digunakan dalam sektor pembinaan. Konkrit merupakan gabungan simen, batu baur kasar, batu baur halus dan air yang dicampurkan mengikut kadar pencampuran tertentu yang telah ditetapkan. Kekuatan konkrit memainkan peranan utama dalam menghasilkan konkrit yang berkualiti. Penekanan dalam piawaian dan spesifikasi bahan, rekabentuk bancuhan, prosedur ujian serta teknik pembinaan telah dibangunkan dalam meningkatkan kualiti konkrit. Kerajaan dan industri juga telah memberi penekanan yang mendalam mengenai konkrit yang berkekuatan tinggi, konkrit yang berprestasi tinggi dan tempoh pembinaan yang lebih cepat (Armaghani, 2010). Hasil daripada penekanan ini, penyelidikan telah memberi tumpuan dalam menghasilkan perubahan dalam sifat-sifat bahan asas konkrit dan pembangunan bahan-bahan baru untuk mencapai konkrit yang lebih berkualiti, berkekuatan tinggi, dan tahan lama.

Malaysia merupakan pengeluar komoditi kedua terbesar pengeluaran minyak sawit di dunia selepas Indonesia. Perangkaan daripada National Biomass Strategi Blueprint menunjukkan menjelang 2020, industri minyak sawit Malaysia dijangka menjana kira-kira 100 juta tan kering biojisim pepejal (Tarmeze, 2012). Industri minyak sawit negara menghasilkan kira-kira 90 juta ton biomas *nikel lignoselulosik*, termasuk batang kelapa sawit, daun kelapa dan efluen penapisan minyak sawit (POME). *Spent Bleaching Earth* (SBE) adalah sisa pepejal yang dihasilkan daripada proses penapisan minyak sawit. *Bleaching earth* digunakan untuk mengeluarkan warna, fosfolipid, produk teroksidasi, logam dan *residual gums* dari minyak (Ubolrat, 2014). Ia juga menyerap kira-kira 0.5% berat minyak semasa proses penapisan minyak sawit. SBE kini dilupuskan secara langsung di tapak pelupusan tanpa rawatan dan boleh menyebabkan pencemaran air dan udara yang teruk (K. Y. Cheonga et.al, 2013). Malah sisa pelupusan yang banyak akan menyebabkan kos pembuangan bahan sisa yang tinggi kepada pengeluar minyak sawit. Longgokan sisa buangan SBE ini boleh dikitar semula bagi mengurangkan longgokan sisa buangan di tapak pelupusan sampah. Kitar semula merujuk kepada pengembalian sesuatu bahan atau produk kepada bentuk lain atau membawa maksud penukaran sisa buangan melalui

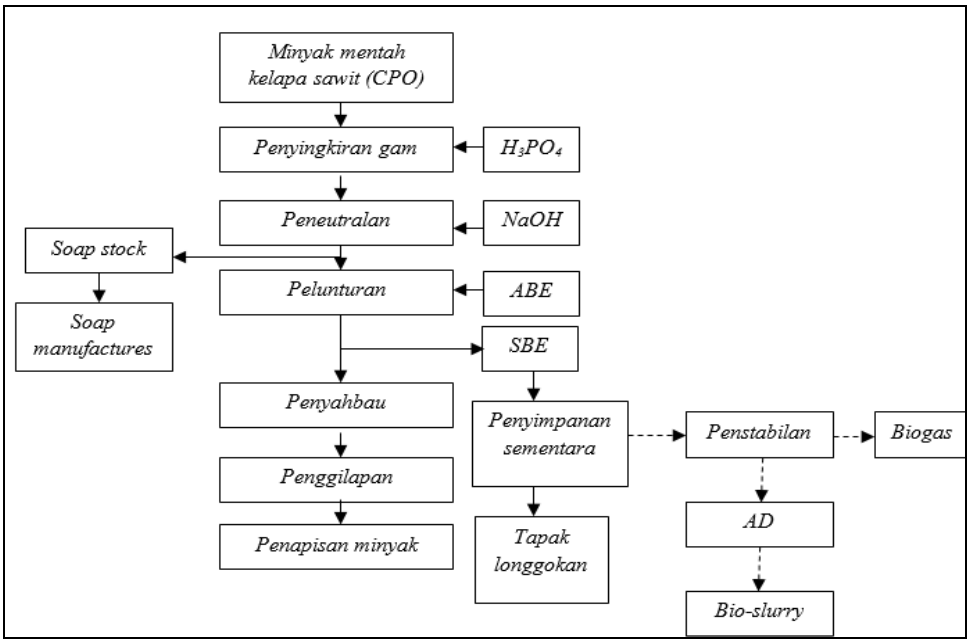
penjanaan aktiviti manusia kepada bahan lain yang boleh dimanfaat dalam penggunaan berbeza (Noor. H. Cheku et al., 2014). Masalah pembuangan SBE dapat dikurangkan dengan menggantikan bahan-bahan konkrit dengan *Environmental Treated Clay* (ETC). ETC diperoleh daripada pengekstrakan *hexane* daripada SBE. Penggunaannya ETC tidak diaplikasi secara praktikal tetapi hanya dilupuskan di tapak pelupusan sampah. Kebelakangan ini banyak perubahan ketara yang berlaku dalam bahan dan sifat konkrit. Kebanyakan konkrit yang dihasilkan tidak kuat dan tidak memenuhi spesifikasi kerana penggunaan bahan mentah yang tidak berkualiti. Struktur konkrit yang dihasilkan mempunyai banyak masalah dalam penambahbaikkan dan penyelenggaraan serta memerlukan kos penyelenggaraan yang tinggi (Diane Gardner, et. al, 2018). Disamping itu, penyelidikan juga telah memberi tumpuan kepada kajian-kajian penambahbaikan bahan baru untuk mencapai konkrit yang lebih berkualiti dan tahan lama. Bahan kitar semula banyak digunakan sebagai bahan gantian dalam rekabentuk campuran konkrit.

Kajian ini dijalankan dengan inovasi baru bancuhan konkrit dengan menggunakan ETC sebagai bahan gantian kepada simen dan pasir. Objektif kajian ini ialah untuk mengkaji sifat konkrit ETC sebagai bahan pengganti simen dan pasir serta menentukan kekuatan mampatan terhadap konkrit gentian ETC. Kajian ini, dibahagikan kepada 2 kumpulan dengan mengubah peratusan ETC dalam bahan mentah utama iaitu 20% dan 30% ETC sebagai bahan gantian simen. Manakala 60% ETC menggantikan pasir dalam nisbah bancuhan yang ditetapkan. Nisbah bancuhan yang digunakan ialah 1:2:4 dengan Gred Konkrit M15. Sampel kiub diuji dengan ujian kekuatan mampatan konkrit setelah dijalankan ujian pengawetan selama 7 hari, 14 hari dan 28 hari. Dengan menggantikan ETC dalam campuran konkrit, ia boleh menyelesaikan untuk masalah pembuangan sisa serta menggunakan bahan yang baru dalam industri pembinaan. Ia dapat mengurangkan kos bahan mentah untuk pengeluar konkrit serta mengurangkan masalah pencemaran alam sekitar.

2.0 SOROTAN KAJIAN

2.1 *Spent Bleaching Earth* (SBE)

Sisa penapisan minyak kelapa sawit mengandungi minyak dan sisa tersebut dibuang di tapak pelupusan sampah. Kuantiti pelupusan mungkin dihadkan oleh peraturan alam sekitar kerana limpahan minyak bawah tanah yang banyak boleh mengakibatkan tindakbalas pembakaran (Mohd Azri bin Sukiran, 2008). Minyak sayuran juga perlu diproses terlebih dahulu bagi menghilangkan kekotoran supaya selamat digunakan bagi tujuan komersial dan kesihatan. Proses tersebut dikenali sebagai pelunturan yang melibatkan *bleaching earth.* Minyak sayuran mengandungi bahan pencemar yang akan mempengaruhi kegunaan, warna dan rasa minyak. Ia mestilah memenuhi kualiti piawaian yang mana memerlukan penyingkiran pelbagai kekotoran supaya selamat digunakan. Proses pelunturan minyak kelapa sawit adalah untuk melunturkan minyak, mengurangkan jumlah klorofil dan *carotenoids* dalam minyak serta menguraikan bahan pengoksidaan. Minyak diluntur dengan menggunakan serbuk yang dinamakan *bleaching earth*. Serbuk dicampur dengan air dan kemudian dimasukkan ke dalam minyak untuk menyerap kekotoran dalam minyak. *Bleaching earth* terdiri daripada tiga jenis mineral tanah liat, iaitu *bentonite*, *attapulgite* dan *sepiolite*. Galian tersebut bertindak sebagai penyerap dengan jumlahnya bergantung kepada struktur dan ciri-ciri mineral seperti luas permukaan, saiz zarah, keliangan dan lain-lain. *Bentonite* adalah batu yang mempunyai keupayaan untuk menyerap bahan yang boleh dilarutkan dalam air. Rajah 2.1 menunjukkan proses pengekstrakan minyak kelapa sawit dan Jadual 2.1 menunjukkan komposisi kimia yang terdapat dalam SBE.



Rajah 2.1: Proses Pengekstrakan Kelapa Sawit (Loh Soh Kheang, et al., 2013)

Jadual 2.1 : Komposisi Kimia *Spent Bleaching Earth* (SBE)

Characteristics	Solvent extraction		SC-CO_2, Extraction	
	WAC (acid-activated oil)	NC (neutral) oil	WAC (acid-activated) oil	NC (neutral) oil
FFA (%)	11.5	12.6	11.5	12.6
PV (meq kg^{-1})	3.1	3.4	2.8	2.2
Phosphorus (ppm)	19.3	18.7	18.1	15.8
Fe (ppm)	0.22	1.24	N.D	N.D
Cu (ppm)	0.32	0.38	N.D	N.D
Carotene content(ppm)	3	6	7	7
Total vitamin E (ppm)	0	0	0	38.8
Fatty acid composition, (FAC) (wt % as methyl esters)				
C14:0	1.1	1.0	1.2	1.3
C16:0	45.2	44.4	44.5	43.6
C18:0	4.9	4.7	5.1	4.9
C18:1	37.9	39.4	38.6	39.7
C18:2	10.9	10.5	10.6	10.5
Oil recovery (%)	30	21	27	20

SBE juga boleh menyerap toksin dari minyak dan lemak sayuran serta meyerap bau busuk. SBE juga boleh digunakan untuk menghasilkan blok tanah liat yang baru untuk industri pembinaan. Kajian terdahulu menunjukkan penggunaan sisa SBE sebagai material bata tanpa proses pembakaran (Wangrakdiskul, 2014). Walaupun banyak kajian tentang manfaat SBE daripada sektor pertanian namun kajian penggunaan SBE sebagai bahan binaan masih belum meluas. SBE boleh dijadikan sebagai pengganti pasir pada campuran mortar bagi proses pembuatan bata konkrit. Lebih besar peratusan menggantikan pasir dengan SBE, kualiti bata konkrit akan menurun dan proses pembuatannya semakin susah (Agung Sumarno, et. al, 2017). Daripada ujian yang dilakukan, penggantian pasir dengan 50% SBE menghasilkan kualiti bata konkrit yang rendah. Dalam bidang pertanian, kandungan nutrein dalam baja organik melalui formula SBE sebagai biojisim pertanian mampu meningkatkan potensi pembajaan (K. Y. Cheonga et.al, 2013). Terdapat beberapa pengkaji yang menggunakan sisa pepejal SBE dalam pelbagai produk. Ann, L. Y. (2010) menggantikan SBE kedalam bancuhan konkrit. Keputusan ujian menunjukkan menunjukkan peningkatan peratusan SBE akan merendahkan nilai kekuatan

mampatan untuk pengawetan dalam air dan udara. Wagrakdiskul, U., et al (2014) menyimpulkan bahawa formula bancuhan yang terbaik penggunaan SBE dalam produk jubin dinding ialah dengan 60.94% tanah laterit, 13.125% pasir fluvial, 22.5% simen Portland dan 3.435% SBE. Nilai kekuatan lenturan yang diperolehi ialah 0.68 MPa. Tee, C. K. (2013) mengkaji penggunaan SBE sebanyak 50% dan 60% dalam bancuhan konkrit. Kajian ini menunjukkannisbah SBE: simen dengan 50:50 menunjukkan nilai kekuatan mampatan yang tinggi berbandingan dengan nisbah 60:40. Environmental Treated Clay (ETC) dierolehi daripada daripada sisa proses pengekstrakan *hexane* daripada SBE. Penggunaan ETC dalam bancuhan konkrit mungkin boleh menyelesaikan masalah pembuangan sisa dalam industri pembinaan.

2.2 Konkrit

Konkrit merupakan kombinasi simen dan batu baur seperti batu baur halus dan batu baur kasar. Bahan-bahan ini dicampurkan berdasarkan nisbah bancuhan yang tertentu. Simen yang terdiri daripada bahan pengikat (kebiasaannya simen Portland) dan air yang mengikat pasir dan batu baur bancuhan seperti batu apabila ia mengeras. Campuran tersebut mengeras disebabkan oleh tindakbalas kimia yang dipanggil penghidratan diantara simen dan air (Raja Mohamad Farhan, 2017). Menurut Woodson (2012), untuk bancuhan konkrit biasa, 1 tan simen (serbuk) akan menghasilkan jumlah isipadu konkrit antara 3.4m^3 hingga 3.8m^3 serta mempunyai berat antara 7 hingga 9 tan untuk setiap bancuhan. Kekuatan dan ketahanan konkrit bergantung kepada beberapa faktor seperti komposisi dan perkadaran bahan-bahan, nisbah air simen, kekuatan dan kadaran saiz batu baur, jenis simen yang digunakan, keseragaman bancuhan dan kaedah penyediaan konkrit. Gred konkrit boleh dibezakan berdasarkan kepada kekuatan konkrit yang boleh digunakan mengikut keperluan penggunaanya.Gred konkrit yang biasa digunakan ialah M15, M20, M25 dan M30. Jadual 2.2 menunjukkan gred normal konkrit dengan nisbah bancuhan konkrit.

Jadual 2.2 : Nisbah Bancuhan Konkrit Mengikut Gred

Gred Konkrit	Nisbah Bancuhan Konkrit
M5	1:5:10
M7.5	1:4:8
M10	1:3:6
M15	1:2:4
M20	1:1.5:3
M35	23.5
M40	27

3.0 METODOLOGI KAJIAN

3.1 Penyediaan sampel bancuhan

Bahan-bahan bancuhan seperti yang ditetapkan disediakan untuk menghasilkan kiub konkrit. 4 nisbah bancuhan yang berbeza disediakan mengikut peratusan nilai ETC yang ditetapkan. Sebanyak 45 kiub yang bersaiz 150mm x 150mm x150mm) dihasilkan dan diawetkan selama 7 hari, 14 hari dan 28 hari.

Jadual 3.1: Jenis-Jenis Sampel Mengikut Peratusan ETC

Sampel	% ETC	Gred	Nisbah Bancuhan
A	0	M15	Simen : Pasir : Batu baur (1 : 2 : 4).
B	20%	M15	Simen : Pasir : Batu baur : ETC (0.8 : 2 : 4 : 0.2)
C	30%	M15	Simen : Pasir : Batu baur : ETC (0.7 : 2 : 4 : 0.3)
D	50%	M15	men : Pasir : Batu baur: ETC (1 : 1.0 : 4 : 1.0)
E	60%	M15	Simen : Pasir : Batu baur: ETC (1 : 0.8 : 4 : 1.2)

3.2 Prosedur bancuhan

Bahan-bahan yang digunakan ditimbang dan pencampuran kering dijalankan untuk simen, agregat dan ETC seperti yang ditunjukkan dalam Rajah 3.1. Agregat halus iaitu pasir diayak untuk mendapatkan saiz minimum 1.18 mm hingga saiz maksimum 2.36mm. Simen, agregat, ETC dan air kemudian ditimbang mengikut nisbah konkrit Gred M15 (1: 2: 4). Campuran ini digaulkering hingga rata dan sempuma. Air dituang sedikit demi sedikit dalam campuran tadi hingga rata dan sebati. Campuran yang telah sebati akan dituangkan ke dalam acuan keluli kiub bersaiz 150 mm x 150 mm x 150 mm. Acuan dan plat asas mesti dibersihkan dan disapukan dengan minyak untuk mencegah konkrit dari melekat pada sisi kiub. Plat asas dipasang pada acuan dengan menggunakan skru. Pemadatan dilakukan untuk mengeluarkan udara yang terdapat dalam campuran konkrit. Ini bertujuan untuk merapatkan rongga yang terbentuk akibat udara yang terperangkap. Bancuhan konkrit diletakkan ke dalam acuan dalam 3 lapisan. Setiap lapisan mesti dipadatkan selama 25 kali. Proses ini perlu dijalankan untuk ketiga-tiga lapisan. Setelah semua bancuhan konkrit telah dimasukkan, ianya perlu diratakan dan dibiarkan mengeras selama 24 jam (Md Nasser Samsudin, 2006). Kemudian, ujian kekuatan mampatan dijalankan keatas sampel kiub pada 7, 14 dan 28 hari menggunakan mesin ujian kekuatan mampatan konkrit.

Rajah 3.1: Percampuran Kering Bahan-Bahan Bancuhan

3.3 Ujian penurunan

Ujian penurunan perlu dilakukan bagi menentukan kebolehkerjaan bancuhan konkrit. Ini untuk memastikan bancuhan konkrit tersebut memenuhi keperluan dan tidak menimbulkan masalah ketika proses perletakan dilakukan. Nilai penurunan untuk kebolehkerjaan sederhana antara 30 mm hingga 60 mm. lanya juga memastikan konsistensi bancuhan konkrit disamping mengawal kekuatannya. Ini merupakan satu ujian kasar yang dilakukan pada sampel bancuhan konkrit yang dibancuhkan pada masa yang berlainan untuk menentukan bahawa bancuhan itu mengandungi jumlah air yang lebih kurang sama tidak terlalu cair atau terlalu kering.

3.4 Ujian pengawetan

Ujian pengawetan merupakan satu kaedah melalui proses hirolisis dan penghidratan dengan meletakan konkrit di bawah satu suhu dan sentiasa lembab pada jangkamasa tertentu untuk memastikan kekuatan sesuatu konkrit mencapai tahap yang maksimun. Konkrit yang telah mengeras diletakkan di dalam air tawar selama beberapa hari bagi mewujudkan tindak balas kimia antara unsur-unsur simen dengan air.

3.5 Ujian kekuatan mampatan

Ujian kekuatan mampatan dijalankan untuk menentukan kekuatan mampatan kiub konkrit pada umur 7 hari, 14 hari dan 28 hari. Mesin pemampat ELE autotest dengan piawai BS 1881. Sebanyak 45 sampel kiub konkrit yang telah diuji. Kiub konkrit yang telah diawetkan perlu dikeringkan sekurang-kurang 1 jam dan ditimbang untuk berat keringnya. Kemudian dikenakan daya mampatan secara automatik perlahan-lahan sehingga kiub konkrit pecah. Bacaan nilai kekuatan direkodkan.

Jadual 3.2: Kekuatan Mampatan Konkrit pada 7 Hari dan 28 Hari

Gred Konkrit	Kekuatan mampatan minimum pada 7 hari (N/mm^2)	Kekuatan mampatan tertentu pada 28 hari (N/mm^2)
M15	10	15
M20	13.5	20
M25	17	25
M30	20	30
M35	23.5	35
M40	27	40

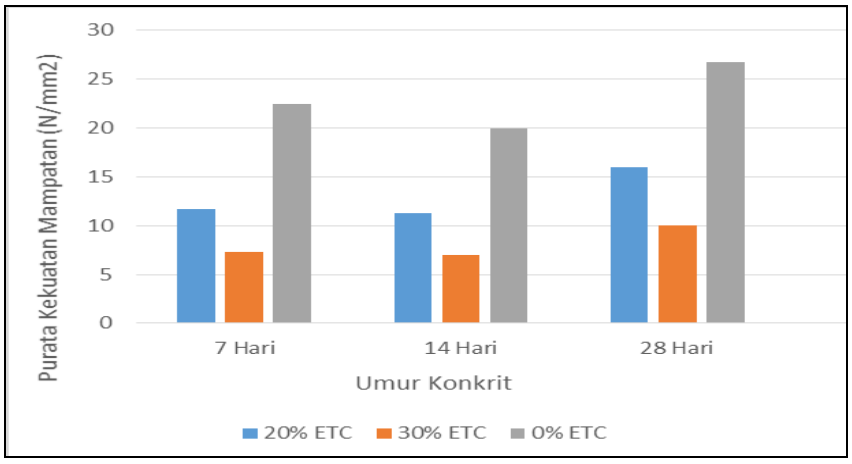
4. 0 ANALISIS DAN KEPUTUSAN

Keputusan kekuatan mampatan konkrit ETC sebagai pengganti simen dan pasir dalam bancuhan konkrit dibandingkan dengan konkrit konvensional. Kekuatan mampatan adalah penting untuk mengenal pasti kekuatan yang dibenarkan yang boleh ditanggung oleh konkrit. Kekuatan mampatan konkrit yang menggantikan simen dan pasir dengan ETC ditentukan pada umur konkrit 7, 14 dan 28 hari di bawah pengawetan air. Purata 5 sampel telah diambil untuk setiap umur dengan keadaan pengawetan air. Sebanyak 45 kiub telah diuji.

4.1 Penggantian 20% dan 30% ETC dengan simen

Table 4.1: Kekuatan Mampatan dengan 0%, 20% dan 30% ETC

Sampel	%ETC	Umur (Hari)	Purata Kekuatan Mampatan (N/mm^2)
A	0%	7	22.5
		14	20.0
		28	26.7
B	20%	7	11.7
		14	11.3
		28	16.0
C	30%	7	7.3
		14	7.0
		28	10.0



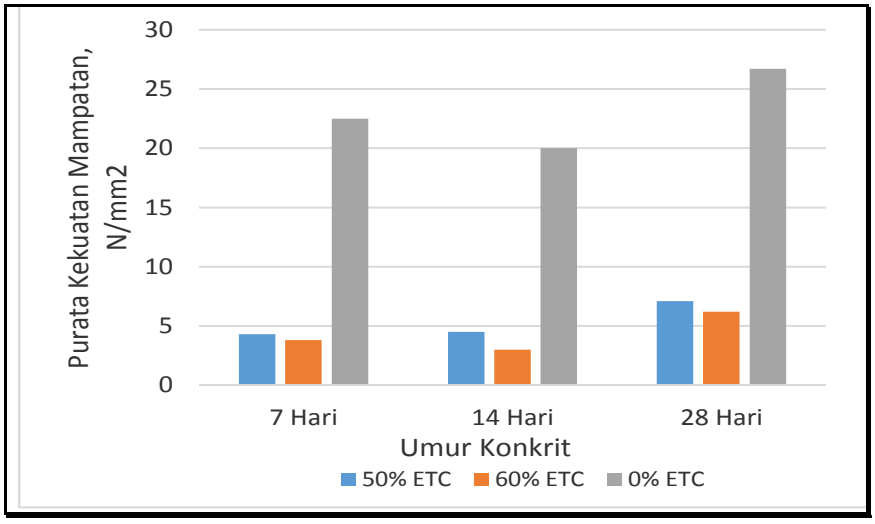
Rajah 4.1: Kekuatan Mampatan Konkrit dengan 0%, 20% dan 30% ETC

Rajah 4.1 menunjukkan carta bar purata kekuatan konkrit dengan peratusan penggantian simen dengan 0% ETC, 20% ETC dan 30% ETC. Keputusan ujikaji menunjukkan konkrit pada umur 7 hari, nilai kekuatan mampatan bagi 20% ETC lebih tinggi dari 30% ETC iaitu dengan nilai 11.7 dan 7.3 N/mm^2. Bagi konkrit yang berumur 14 hari pula, nilai kekuatan mampatan bagi 20% ETC lebih tinggi dari 30% ETC iaitu dengan nilai 11.3 N/mm^2 dan 7 N/mm^2. Manakala bagi konkrit yang berumur 28 hari, nilai kekuatan mampatan bagi 20% ETC lebih tinggi dari 30% ETC iaitu dengan nilai 16 N/mm^2 dan 10 N/mm^2. Keputusan menunjukkan pertambahan peratusan ETC dalam bancuhan konkrit akan menyebabkan penurunan nilai kekuatan mampatan. Kekuatan mampatan yang paling tinggi dicatatkan bagi 20% ETC pada umur konkrit 28 hari iaitu 16 N/mm^2. Jika dibandingkan dengan Jadual 3.2, hanya konkrit 20% ETC pada 7hari, 14 hari dan 28 hari sahaja melepasi nilai kekuatan mampatan minimum yang ditetapkan iaitu 10 N/mm^2. Ini menunjukkan hanya konkrit 20% sahaja yang melepasi nilai kekuatan mampatan minimum yang ditetapkan. Nilai kekuatan mampatan yang tidak mencapai nilai yang ditetapkan mungkin disebabkan nisbah air simen yang kurang sesuai, sifat batu baur dan kaedah pemadatan yang kurang sempurna. Jika dibandingkan dengan 0% ETC, nilai kekuatan mampatan ialah jauh lebih rendah iaitu 22.5 N/mm^2.

4.2 Penggantian 50% dan 60% ETC dengan simen

Table 4.2: Kekuatan Mampatan dengan 0%, 50% dan 60% ETC

Sampel	%ETC	Umur (Hari)	Purata Kekuatan Mampatan (N/mm^2)
A	0%	7	22.5
		14	20.0
		28	26.7
D	50%	7	4.3
		14	4.5
		28	7.1
E	60%	7	3.8
		14	3.0
		28	6.2



Rajah 4.1: Kekuatan Mampatan Konkrit dengan 0%, 50% dan 60% ETC

Rajah 4.2 menunjukkan carta bar purata kekuatan konkrit dengan peratusan penggantian pasir dengan 0% ETC, 50% ETC dan 60% ETC. Keputusan ujikaji menunjukkan konkrit pada umur 7 hari, nilai kekuatan mampatan bagi 50% ETC lebih tinggi dari 60% ETC iaitu dengan nilai 4.3 dan 3.8 N/mm^2. Bagi konkrit yang berumur 14 hari pula, nilai kekuatan mampatan bagi 20% ETC lebih tinggi dari 30% ETC iaitu dengan nilai 4.5 N/mm^2 dan 3.0 N/mm^2. Manakala bagi konkrit yang berumur 28 hari, nilai kekuatan mampatan bagi 20% ETC lebih tinggi dari 30% ETC iaitu dengan nilai 7.1 N/mm^2 dan 6.2 N/mm^2. Keputusan menunjukkan pertambahan peratusan

ETC dalam bancuhan konkrit akan menyebabkan penurunan nilai kekuatan mampatan. Kekuatan mampatan yang paling tinggi dicatatkan bagi 50% ETC pada umur konkrit 28 hari iaitu 7.1 N/mm^2. Jika dibandingkan dengan Jadual 3.2, kesemua konkrit yang menggantikan pasir dengan ETC tidak melepasi nilai kekuatan mampatan minimum yang ditetapkan iaitu 10 N/mm^2. Ini menunjukkan hanya konkrit 20% sahaja yang melepasi nilai kekuatan mampatan minimum yang ditetapkan. Nilai kekuatan mampatan yang tidak mencapai nilai yang ditetapkan mungkin disebabkan nisbah air simen yang kurang sesuai, sifat batu baur dan kaedah pemadatan yang kurang sempurna. Jika dibandingkan dengan 0% ETC, nilai kekuatan mampatan ialah jauh lebih rendah iaitu 22.5 N/mm^2.

5.0 KESIMPULAN

Daripada keputusan ujian kekuatan mampatan yang dijalankan, dapat disimpulkan bahawa konkrit yang menggantikan simen dengan 20% ETC dan 30% ETC menunjukkan kekuatan mampatan yang rendah berbanding dengan kekuatan minimum Gred M15. Konkrit yang menggantikan pasir dengan 50% ETC dan 60% ETC juga tidak mencapai nilai kekuatan minimum bagi Gred M15. Antara cadangan yang boleh diambilkira ialah dengan menggunakan bahan tambah kedalam rekabentuk bancuhan konkrit untuk meningkatkan kekuatan mampatan konkrit. Penggunaan ETC mungkin boleh diaplikasikan dalam proses pembuatan bata kerana kekuatan mampatan bata tidak boleh kurang daripada 7 N/mm^2. Menurut BIS: 1077-1957, kekuatan mampatan minimum bata ialah 3.50 N/mm^2.

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KEBERKESANAN PENGGUNAAN TEMPURUNG KELAPA SAWIT DALAM PEMBUATAN BATA SIMEN

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ABSTRAK

Minyak sawit adalah salah satu sumber domestik yang mempunyai pelbagai kegunaan dan yang paling banyak digunakan di dunia. Malaysia berada di ranking kedua pengeluar minyak kelapa sawit dunia dan pada tahun 2016 mencatatkan pengeluaran sehingga 21 juta tan. Justeru itu, negara telah menghasilkan tempurung kelapa sawit melebihi 4 juta tan setahun. Kajian ini telah menggunakan tempurung kelapa sawit yang mengandungi lignoselulosa dan karbon sebagai bahan ganti dalam bancuhan batu bata simen. Kepesatan dalam bidang pembinaan menyebabkan peningkatan permintaan dalam industri batu bata seterusnya meningkatkan kos batu bata meningkat. Sehubungan dengan itu, penggunakan bahan alternatif seperti tempurung kelapa sawit sebagai bahan gantian dalam menghasilkan bata simen wajar diperluaskan pengkajian mengenainya untuk dijadikan inovasi dalam menghasilkan bata alternative dimasa hadapan. Objektif kajian ini adalah untuk mengkaji kekuatan mampatan, ketumpatan dan kadar resapan air pada bata simen yang dihasilkan dengan mencampurkan tempurung kelapa sawit sebagai bahan gantian. Kajian ini dilaksanakan dengan menghasilkan bata bersaiz 216mm x 103mm x 65mm. Tempurung kelapa sawit telah digunakan untuk menggantikan pasir dengan nisbah 10%, 30% dan 50% berdasarkan unit isipadu. Dapatan daripada kajian menunjukkan bata simen yang menggunakan tempurung kelapa sawit dengan nisbah 30% mempunyai kekuatan mampatan yang paling tinggi iaitu 7.4 N/mm^2, ketumpatan 2.37m^3/kg dan kadar resapan sebanyak 4.85%.Kajian ini menunjukkan tempurung kelapa sawit mempunyai potensi untuk dijadikan bahan alternative dalam pembuatan bata simen untuk projek perumahan kos rendah atau bahagian dinding yang mempunyai beban galas yang rendah. Penghasilan bata dengan campuran tempurung kelapa sawit akan menyumbangkan kepada penurunan kos bata simen dan seterusnya menurunkan kos pembinaan rumah untuk masa akan datang.

Kata Kunci: *tempurung kelapa sawit, bata simen, kekuatan sampatan, ketumpatan, kadar sesapan air*

1. PENGENALAN

Pembangunan dalam industri pembinaan yang kian memuncak di dekad ini menyumbang kepada permintaan yang tinggi terhadap penggunaan bata. Justeru, penghasilan bata yang merupakan salah satu daripada bahan binaan yang penting telah dihasilkan dalam pelbagai jenis mengikut tujuan kegunaanya. Secara umum, di Malaysia terdapat bata tanah liat, bata batu api dan bata simen. Teknologi pembinaan bata telah menghasilkan pelbagai jenis bata dicipta dengan pelbagai kekuatan dan saiznya serta nilai estika. Seiring dengan itu, pelbagai kaedah untuk menghasilkannya telah dikaji bagi mengurangkan kos dan menambah kebolehkerjaannya

Manakala asas pembinaan bata simen adalah menggunakan simen dan pasir dengan nisbah 1:6. Bagi bata jenis ini, kandungan air dalam setiap bancuhan perlulah dijaga dengan baik agar kandungan air di dalam bancuhan tidak berlebihan. Kajian yang berterusan perlu diteruskan untuk memastikan penggunaan bata alternatif akan terus dapat digunakan pada masa yang akan datang. Sehubungan dengan itu, bahan-bahan alternatif dikaji samada boleh digunakan untuk menggantikan bahan asas pembinaan bata seperti pasir yang mana kos nya semakin meningkat berikutan permintaan yang semakin meningkat.

Dalam kajian ini, kekuatan mampatan bata campuran tempurung kelapa sawit yang dihasilkan di uji samada mencapai tahap standard bata simen yang sediada. Saiz tempurung kelapa sawit yang digunakan

disesuaikan mengikut saiz pasir menggunakan proses ayakan dan melepasi saiz ayakan 4.75mm. Eksprimen dijalankan mengikut BS 6073: Part 1: 1981, dimana nisbah bancuhan yang digunakan adalah 1:6 iaitu campuran simen dan pasir. Penggunaan bata adalah bersaiz 216.5mm x 102.5mm x 65mm dengan peratus penggunaan tempurung kelapa sawit sebagai bahan ganti kepada pasir ialah 10%, 30% dan 50%.

Tempurung kelapa sawit seperti dalam **Rajah 1** digunakan dalam kajian ini adalah bahan sisa dalam industri pengeluaan kelapa sawit. Dalam proses pengeluaran minyak sawit, tempurung kelapa sawit diasingkan sebagai bahan buangan yang memerlukan ruang yang khusus.Oleh itu, penggunaan bahan ini dalam pembinaan bata simen diharapkan boleh mengurangkan ruang untuk pembuangan sisa kelapa sawit di kilang-kilang pemprosesan kelapa sawit.

Rajah 1: Keratan Rentas Kelapa Sawit

Kajian menunjukkan tempurung kelapa sawit ini mempunyai sifat yang Specific gravity dan specific gravity bagi tempurung kelapa sawit adalah 1462kg/m3 dan 1.46 (.A Olanipekun, 2006).

Rajah 2: Proses Pengasingan Tempurung Kelapa Sawit

Rajah 2 menunjukkan struktur sisa tempurung kelapa sawit selepas proses pengisaran dan pengasingan dari kilang memproses kelapa sawit yang perlu di uruskan bagi memelihara alam sekitar untuk kelestaraian sistem ekologi. Statistik yang dikeluarkan oleh Malysia Palm Oil Board (2018) menunjukkan pengeluaran kernel sawit melebihi 7 juta tan setahun seperti dalam **Jadual 1** dan **2**.

Jadual 1: Pengeluaran Kernel Sawit (Januari-Jun 2017& 2018)(unit tonnes)

States	Jan		Feb		Mar		Apr		May		Jun		Jan - Jun Total	
	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018
JOHOR	58,882	79,506	61,928	60,225	62,834	71,698	62,436	66,787	63,398	65,966	57,930	54,968	367,408	399,150
KEDAH	3,999	5,859	5,210	4,750	7,065	5,690	7,200	5,117	7,332	5,201	6,333	4,725	37,139	31,342
KELANTAN	3,709	6,890	3,558	5,751	4,512	6,457	5,791	6,073	6,178	4,995	5,004	3,884	28,752	34,050
NEGERI SEMBILAN	9,725	16,696	12,317	14,233	16,667	19,401	16,544	17,370	15,141	16,869	13,976	12,141	84,370	96,710
PAHANG	42,223	65,405	42,858	57,442	55,002	67,127	60,900	64,892	53,191	58,245	54,134	44,864	318,308	357,975
PERAK	32,499	39,660	38,999	31,013	54,704	43,044	51,915	40,162	52,411	43,150	46,593	38,009	277,121	235,038
SELANGOR	9,136	12,172	10,435	10,155	13,816	13,036	13,110	12,368	13,264	11,937	11,523	10,814	71,284	70,482
TERENGGANU	7,889	10,540	6,420	9,288	8,211	9,981	8,055	10,204	9,266	8,836	7,586	7,132	45,427	55,981
OTHER STATES	**3,674**	**5,120**	**3,929**	**3,986**	**4,930**	**6,255**	**4,987**	**5,527**	**5,582**	**5,518**	**4,140**	**4,281**	**27,242**	**30,687**
P. MALAYSIA	**171,736**	**241,848**	**185,654**	**196,843**	**225,741**	**242,689**	**230,938**	**228,500**	**235,763**	**220,717**	**207,219**	**180,818**	**1,257,051**	**1,311,415**
SABAH	77,647	109,300	73,257	93,147	85,517	101,331	94,911	98,776	102,446	90,136	95,707	73,433	529,485	566,123
SARAWAK	60,799	67,276	57,158	50,718	63,272	60,904	61,457	65,727	67,065	70,134	67,902	61,480	377,653	376,239
SABAH/SARAWAK	**138,446**	**176,576**	**130,415**	**143,865**	**148,789**	**162,235**	**156,368**	**164,503**	**169,511**	**160,270**	**163,609**	**134,913**	**907,138**	**942,362**
MALAYSIA	**310,182**	**418,424**	**316,069**	**340,708**	**374,530**	**404,924**	**387,306**	**393,003**	**405,274**	**380,987**	**370,828**	**315,731**	**2,164,189**	**2,253,777**

Jadual 2: Pengeluaran Kernel Sawit (Jul-Dec 2017& 2018)(unit tonnes)

States	Jul		Aug		Sep		Oct		Nov		Dec		Jan - Dec Total	
	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018
JOHOR	78,854	67,713	83,670	76,563	84,761	85,963	94,625	88,829	93,033	81,024	91,659	78,119	894,010	877,361
KEDAH	8,040	5,473	8,034	6,067	7,056	7,121	7,189	7,098	6,981	6,751	6,724	6,856	81,163	70,708
KELANTAN	6,504	4,045	7,653	4,998	8,456	6,856	10,173	7,824	8,535	7,706	8,366	7,447	78,439	72,926
NEGERI SEMBILAN	15,802	13,138	14,776	13,542	16,229	16,880	19,133	18,051	19,770	16,527	20,478	15,938	190,558	190,786
PAHANG	68,781	46,667	68,852	53,943	69,184	66,255	78,101	68,623	77,409	65,767	76,297	69,380	756,932	728,610
PERAK	56,789	49,211	54,035	49,155	47,814	52,751	48,133	52,878	46,640	45,259	41,721	43,904	572,253	528,196
SELANGOR	14,063	13,093	13,242	13,605	13,266	14,209	12,800	14,128	13,300	11,977	12,727	11,168	150,682	148,662
TERENGGANU	11,442	8,263	13,508	9,063	14,041	11,797	16,020	13,572	15,068	12,692	13,025	12,169	128,531	123,537
OTHER STATES	**5,899**	**4,863**	**5,582**	**5,037**	**4,814**	**5,663**	**5,851**	**5,921**	**5,797**	**5,685**	**5,484**	**6,155**	**60,669**	**64,011**
P. MALAYSIA	**266,174**	**212,466**	**269,352**	**231,973**	**265,621**	**267,495**	**292,025**	**276,924**	**286,533**	**253,388**	**276,481**	**251,136**	**2,913,237**	**2,804,797**
SABAH	102,532	77,052	96,107	80,504	94,537	98,038	115,493	115,419	116,278	120,362	112,744	122,184	1,167,176	1,179,682
SARAWAK	79,466	71,702	82,283	85,206	81,792	97,262	91,448	93,323	82,069	77,974	75,837	73,208	870,548	874,914
SABAH/SARAWAK	**181,998**	**148,754**	**178,390**	**165,710**	**176,329**	**195,300**	**206,941**	**208,742**	**198,347**	**198,336**	**188,581**	**195,392**	**2,037,724**	**2,054,596**
MALAYSIA	**448,172**	**361,220**	**447,742**	**397,683**	**441,950**	**462,795**	**498,966**	**485,666**	**484,880**	**451,724**	**465,062**	**446,528**	**4,950,961**	**4,859,393**

Sumber: Malysia Palm Oil Board, 2018

2. SOROTAN KAJIAN DAN PEMBINAAN HIPOTESIS

Kajian mengenai penggunaan tempurung kelapa dan tempurung kelapa sawit dalam bidang kejuruteraan giat dilakukan untuk mengenalpasti keupayaan bahan-bahan ini untuk dijadikan bahan alternative dalam industri konkrit, bata dan jalan raya. Kajian –kajian sebelum ini banyak mengkaji penggunaan tempung kelapa dalam industri pembinaan seperti dalam kajian (.A Olanipekun, 2006) (Parag S. Kambli at el, 2014), (P. Madhu Bala,2016), (Kumar Animesh, 2017). Daripada kajian mereka, tempurung kelapa berpotensi jika digunakan sebahgai bahan gantian aggregate dan sebagai simen dalam pembinaan bata dan konkrit.

Dalam kajian ini, tempurung kelapa sawit untuk digunakan sebagai bahan gantian pasir dalam bancuhan bata simen. Walaupun pasir adalah sumber semula jadi dan mudah diperolehi, namun permintaan yang tinggi dalam pembuatan bata dadn konkrit untuk pembinaan bangunan menyebabkan banyak sungai-sungai yang mempunyai sumber pasir terjejas. Proses hakisan tebing sungai dan pemendapan sungai mengganngu kelastarian sungai-sungai yang berkaitan.

2.1 Cengkerang kelapa sawit

Kajian-kajian sebelum ini menggunakan cengkerang kelapa sawit dalam bentuk abu terbang yang digunakan sebagai bahan ganti simen dalam pembinaan konkrit. Hasil daripada kajian (*Md Nasser, 2006*) dan beberapa pensyarah daripada USM, UTM dan UMP mendapati abu terbang daripada tempurung kelapa sawit boleh menggantikan simen dan menjadikan konkrit lebih kukuh dan tahan lama.

Kajian mengenai sifat fizikal tempurung kelapa sawit mempunyai ketumpatan pukal antara 550 kg/m^3 ke 650 kg/m^3 dan gravity tentunya pula ialah 1.25. Ini akan membolehkan sesuatu beban mati sesuatu struktur dapat dikurangkan dan saiz struktur tersebut dapat dikecilkan. (*Teo et all, 2006*)

Manakala cengkerang kelapa sawit yang mempunyai pelbagai jenis bentuk dan saiz .hasil daripada proses penghancuran untuk mendapatkan kernel, mempunyai ketumpatan 1.406 kg/m^3 dan gravity tentunya adalah 2.08. (*Mohd Rashid, 1990*). Jadual 3 menunjukkan perbandingan sifat pasir dan tempurung kelapa sawit.

Jadual 3 : Perbandingan Pasir Sungai dan Tempurung Kelapa Sawit

Parameter	Pasir Sungai	Tempurung kelapa sawit
Saiz maksimum (mm)	1.18	15
Ketebalan Tempurung (mm)	2.0-	0.5 - 3.0
Specifik graviti	2.45	1.17
Ketumpatan (kg / m^3)	1500 – 1550	550 – 650
Index saiz purata	1.40	6.08
Peratus Resapan Air untuk 24 Jam (%)	3.89	33.0

Sumber: khairulaizadaa05

Dalam kajian ini, fokus adalah untuk menentukan peratusan optimum penggunaan tempurung kelapa sawit dalam menghasilkan kekuatan mampatan bata simen yang paling maksima. Sebagai sebuah negara pengeluar minyak kelapa sawit dan minyak kernel kelapa sawit, tempurung kelapa sawit lebih mudah diperolehi sebagai bahan sisa kelapa sawit. Longgokan sisa kelapa sawit ini memerlukan penambahan ruang dari hari ke hari. Oleh itu, kajian penggunaan tempurung kelapa sawit sangat penting dijalankan untuk menyelesaikan permasalah ini.

2.2. Komposisi Utama simen

Simen adalah bahan yang mempunyai lekitan semasa basah, kemudian memejal dan mengeras serta mengikat pepejal menjadi jasad yang padu. Simen boleh dikategorikan sebagai simen hidraulik dan simen bukan hidraulik. Simen hidraulik boleh memejal dan mengeras dengan bertindakbalas dengan air manakala simen bukan hidrulik memerlukan udara untuk mengeras. Jadual 4 menunjukkan sebatian dan komposisi kimia pada simen yang mempengaruhi tindak balasnya.

Jadual 4: Sebatian dan Komposis Kimia Pada Simen

Nama Sebatian	Komposisi Kimia	Ringkasan
Trikalsium Silikat	**$3CaO.SiO_2$**	**C_3S**
Dwikalsium Silikat	**$2CaO.SiO_2$**	**C_2S**
Trikalsium Aluminat	$3CaO.AI_2O_3$	C_3A
Tetrakalsium Alumino Ferit	$4CaO.AI_2O_3.Fe_2O_3$	C_4AF

Sumber: Abdullah b Ahmaad, Utm-'05/'06

Di antara empat sebatian utama ini, C_3S dan C_2S adalah paling stabil. Apabila bercampur dengan air, C_3S akan terhidrat dengan cepat dan melepaskan haba yang banyak pada peringkat awalnya. Manakala C_2S pula terhidrat dengan perlahan dan kekal terhidrat dengan jangka masa yang panjang. C_2S juga didapati mempunyai rintangan kimia yang lebih baik dan kecutan pengeringan yang rendah. Berbanding dengan C_3S dan C_2S, C_3A adalah yang tercepat mengalami proses penghidratan dengan pelepasan haba yang tinggi. Tetapi sumbangan C_3A kepada kekuatan adalah sangat sedikit dan ianya mudah diserang sulfat. Bagi C_4AF pula adalah yang paling cepat terhidrat tetapi kesan pemejalan dan kekuatannaya adalah paling rendah.

3. METODOLOGI KAJIAN

Kajian ini melibatkan beberapa peringkat iaitu bermula dengan mengumpulkan tempurung kelapa sawit daripada kilang pemprosesan minyak sawit yang terletak di Negeri Sembian.Fasa seterusnya adalah proses ayakan tempurung kelapa sawit menggunakan BS410 mengikut spesifikasi Jabatan Kerja Raya (PWD,2008). Dalam kajian ini, tempurung kelapa sawit yang melepasi saiz 4.75 mm digunakan dalam pembinaan bata simen.

Rekabentuk kajian adalah menentukan dengan menentukan peratus pengunaan tempurung kelapa sawit sebgai bahan gantian dalam pembuatan bata simen dengan merujuk kepada MS 27. Nisbah campuran yang digunakan adalah 1:6 dimana 1(simen) dan 6(pasir) dalam kiraan isipadu. Sebahagian daripada isipadu pasir digantikan dengan tempurung kelapa sawit dengan nisbah 10%, 30% dan 50%. Nisbah bancuhan adalah seperti Jadual 5.

Jadual 5: Nisbah Bancuhan Kajian

Bata	Nisbah	Pasir	Tempurungkelapa sawit
Bata A	1:6	90% pasir	10%
Bata B	1:6	70% pasir	30%
Bata C	1:6	50% pasir	50%
Bata simen	1:6	100% pasir	-

3.1 Proses Menggaul Campuran Bata

Proses menggaul simen dan pasir dibancuh berasingan mengikut peratusan gantian serbuk tempurung kelapa sawit 10% , 30% dan 50% . Campuran-campuran ini adalah berdasarkan berat bahan yang digunakan. Bagi memastikan campuran- campuran tersebut benar- benar rata, proses menggaul dijalankan sehingga campuran tersebut menjadi jelekit dan sekata. **Rajah 3** menunjukkan proses menggaul campuran bata.

Rajah 3: Proses Menggaul Campuran Bata

3.1 Proses memadatkan campuran ke dalam acuan bata

Campuran bata simen dimasukkan ke dalam acuan yang telah di siapkan terlebih dahulu untuk 10 biji batu bata. Saiz acuan bagi setiap bata yang terhasil adalah 216.5mm x 102.5mm x 65mm Campuran dipadatkan bagi mengelakkan ruang- ruang terhasil ditengah bata dan bagi memastikan bata yang terhasi rata dan sempurna. Rajah 4 menunjukkan campuran bata didalam acuan selepas prosespemadatan.

Rajah 4 : Campuran Bata Dalam Acuan

3.2 Proses Pengawetan

Selepas semalaman sampel bata tadi dikeringkan dan mengalami proses pengerasan yang sempurna, bata akan di sembur dengan air, agar ia mengeras dengan kehadiran air. Rajah 5 menunjukkan bata yang dikeringkan.

Rajah 5: Proses Mengawet Bata

3.3 Ujian prestasi yang dilakukan ke atas bata

Dalam kajian ini, beberapa ujian dijalankan terhadap bata simen campuran tempurung kelapa sawit ini. Antara ujian-ujian tersebut ialah ujian kekuatan mampatan dan ujian kadar resapan air.

3.3.1 Ujian mampatan

Ujian kekuatan mampatan dilakukan berdasarkan BS 66073 : Part 1 : 1981. Untuk mendapatkan kekuatan bata tersebut. Bata yang telah mencapai usia 7, 14 dan 28 hari akan dimasukkan ke dalam mesin mampatan seperti dalam Rajah 6 untuk mendapatkan nilai bacaan kekuatan mampatan bata tersebut.

Rajah 6: Ujian Mampatan Bata

3.3.2 Ujian resapan air

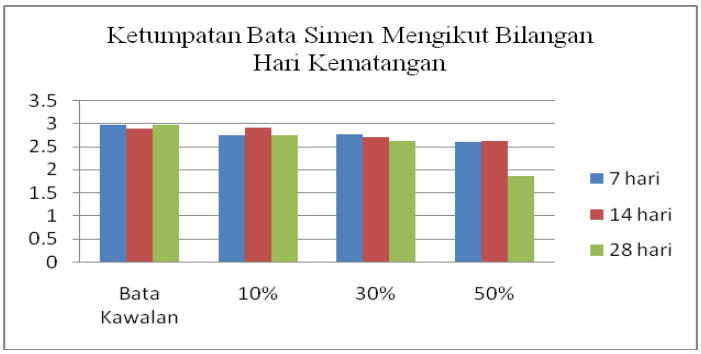
Kajian di teruskan dengan menguji kadar resapan air menggunakan MS 30 untuk menentukan peratus penyerapan air pada bata campurang serbuk tempurung kelapa sawit. Ujian resapan air dijalankan terhadap bata yang telah mencapai usia 1 hari, dimana selepas ianya siap dihasilkan bata akan dibiarkan kering selama 24 jam dan selepasnya dikeringkan dalam oven selama tidak kurang daripada 24 jam pada suhu 1oo•c sehingga tiada perubahan berat, iaitu semua lembapan di dalam contoh telah dihilangkan. Sebelum penimbangan dibuat ia hendaklah disejukkan pada suhu makmal. Perubahan berat direkodkan sebelum dan selepas rendaman dibuat.

4. ANALISIS DAN KEPUTUSAN

Dapatan daripada kajian yang telah dijalankan direkodkan seperti dalam Jadual 6, 7, 8 dan 9. Nilai ketumpatan bata simen seperti dalam Jadual 6 menggunakan tempurung kelapa sawit menurun dengan penambahan peratus tempurung kelapa sawit dalam bancuhan. Ini menunjukkan bata simen mempunyai potensi untuk menjadi bata yang lebih ringan sekiranya tempurung kelapa sawit digantikan dengan pasir.

Jadual 6: Nilai Ketumpatan Bata

Parameter	Ketumpatan (kg/m^3)		
	7 hari	14 hari	28 hari
Bata Kawalan	2.97	2.88	2.96
10%	2.73	2.9	2.73
30%	2.75	2.70	2.61
50%	2.6	2.62	1.86

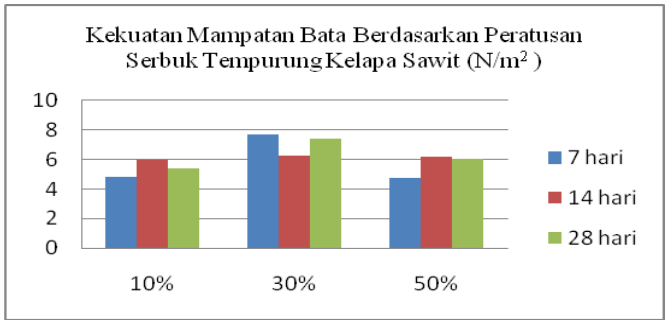


Rajah 7: Graf Ketumpatan Bata

Manakala nilai kekuatan mampatan bata simen yang dihasilkan seperti dalam Jadual 7, menunjukkan peratus penggunaan tempurung kelapa sawit sebanyak 10%, 30% dan 50% mempunyai kekutan mampatan melebihi kekuatan mampatan bata simen biasa iatu melebihi 5.2 N/mm. Walaubagaimanapun peratusan tempurung kelapa sawit sebanyak 30% menunjukkan kekutan mampatan yang paling tinggi iaitu 7.40N/mm^2.

Jadual 7 : Nilai Kekuatan Mampatan Bata

Parameter	Kekuatan Mampatan (N/mm^2)		
	7 hari	14 hari	28 hari
Bata Kawalan	4.1	2.71	2.16
10%	4.8	5.96	5.39
30%	7.7	6.27	7.40
50%	4.76	6.19	6.06

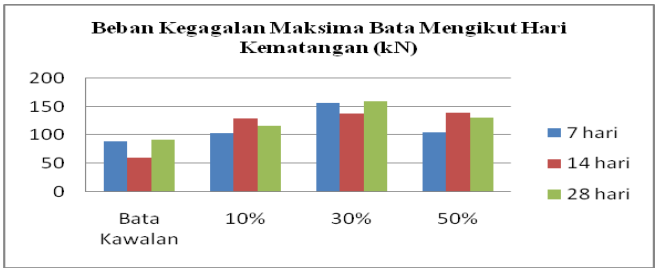


Rajah 8: Graf Kekuatan Mampatan Bata

Dapatan daripada kajian ini juga menunjukkan nilai kekuatan menanggung beban seperti dalam Jadual 8,dimana beban kegagalan maksima adalah paling tinggi dengan penggunaan 30% tempurung kelapa sawit.

Jadual 8: Nilai Menanggung Beban

Parameter	Beban Kegagalan Maksima (kN)		
	7 hari	14 hari	28 hari
Bata Kawalan	88.67	60.5	91.67
10%	103.33	130.03	116.00
30%	156.33	138.10	159
50%	104.67	139.30	130.30

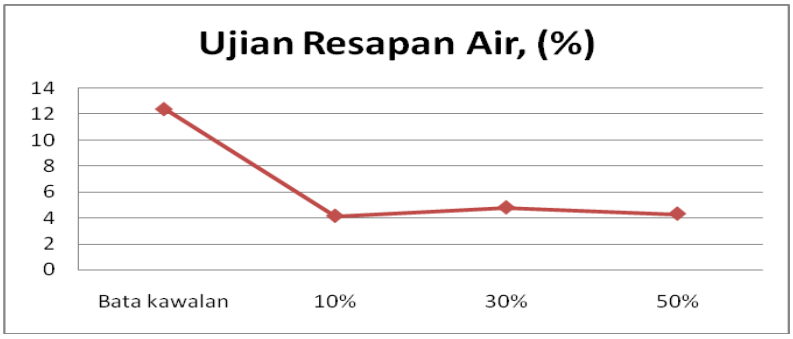


Rajah 9: Graf Menanggung Beban

Jadual 9 menunjukkan dapatan ujian serapan air yang telah dijalankan. Daripada kajian ini, didapati nilai purata kadar resapan air bagi bata simen yang telah dihasilkan dengan campuran tempurung kelapa sawit adalah 4.41% dimana kurang daripada 8% seperti dalam MS30.

Jadual 9: Kadar Resapan Air Bata

Parameter	Kadar Resapan Air			
	Bata kawalan	10%	30%	50%
Jumlah resapan	0.34	0.11 kg	0.12 kg	0.11
Peratus resapan	12.41%	4.14%	4.80%	4. 31%



Rajah 10: Graf Kadar Resapan Air Bata

5. KESIMPULAN

Secara keseluruhan, kajian ini menunjukkan tempurung kelapa sawit mempuyai nilai tambah untuk dijadikan sebagai bahan gantian dalam bancuhan bata simen. Peratusan campuran tempurung kelapa sawit sebanyak 30% adalah paling optima untuk digunakan dalam penghasilan bata simen dengan kekuatan mampatan 7.4N/mm^2, nilai menanggung beban adalah 159kN, ketumpatan 2.61 dan kadar resapan air 4.85%. Daripada nilai ini didapati tempurung kelapa sawit mempunyai potensi untuk digunakan sebagai bahan untuk digantikan dengan pasir dalam bancuhan bata simen. Justeru, penghasilan bata simen campuran kelapa sawit boleh dijadikan alternatif yang akan dapat mengurangkan kos bata itu sendiri, seterusnya diharapkan dapat menurunkan kos perumahan untuk masa akan datang.

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PENGGUNAAN ABU TONGKOL JAGUNG SEBAGAI BAHAN GANTI SEPARA SIMEN DALAM PENGHASILAN BATA TANPA BAKAR

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ABSTRAK

Pada zaman kini, masalah kekurangan bahan mentah dan kos yang tinggi dalam pembinaan menyebabkan sesetengah pihak mencari alternatif yang lain untuk menjimatkan kos dan mendapatkan keuntungan yang lebih. Bata abu tongkol jagung adalah bata tanpa bakar yang diperbuat daripada tanah merah, simen dan pasir di mana abu tongkol jagung sebagai bahan ganti separa simen. Tujuan kajian ini adalah untuk menghasilkan bata merah yang mempunyai kekuatan yang tinggi dan menentukan tahap penyerapan air. Ukuran saiz bata yang dihasilkan adalah mengikut saiz piawai 215mm x 102.5mm x 65mm. Rupa bentuk bata abu tongkol jagung adalah segi empat tepat dengan permukaan yang rata. Tongkol jagung dibakar dengan api yang bersuhu 400°C sehingga menjadi arang. Arang tongkol jagung tersebut ditumbuk sehingga halus dan menjadi abu yang dipanggil abu tongkol jagung. Abu tongkol jagung tersebut dicampurkan ke dalam adunan simen, tanah merah, dan pasir menggunakan peratusan yang spesifik dalam komposisinya. Peratus abu tongkol jagung yang digunakan sebagai bahan ganti separa simen adalah 10% dan 50%. Daripada hasil kajian ini, didapati purata kekuatan bata yang menggunakan 10% dan 50% abu tongkol jagung ialah 5.78 N/mm² dan 5.95 N/mm². Merujuk kepada JKR Standard Specifications For Building Works 2005 ditetapkan kekuatan mampatan bata adalah 5.20 N/mm². Berdasarkan keputusan yang diperolehi dengan penggantian abu tongkol jagung dapat meningkatkan kekuatan mampatan dan ketahanlasakan bata manakala ketumpatan bata berkurangan. Ini menunjukkan bata yang menggunakan abu tongkol jagung sebagai bagan ganti separa simen adalah sesuai dijadikan sebagai alternatif penghasilan bata dan dalam masa yang sama dapat mengurangkan pembuangan sisa tongkol jagung yang terhasil daripada kilang dan pertanian.
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KATA KUNCI: *Bata Abu Tongkol Jagung, Bata Tanah Merah, Simen.*

1. PENGENALAN

Peningkatan pembuatan bata yang bermutu tinggi dan mempunyai kekuatan yang baik serta sifatnya yang ringan, mudah disediakan, bentuk dan saiz seragam telah menjadikan bata salah satu bahan binaan yang sering digunakan dalam industri pembinaan. Terdapat juga beberapa kajian untuk menggantikan separa simen dalam penghasilan bata seperti abu kelapa sawit (Md Nasser, 2006), abu terbang (Muhammad Waridi, 2015), kulit telur dan sisa enap kumbahan (Nor Fadzillah, 2016) menunjukkan kesan positif yang boleh digunakan sebagai bahan binaan kejututeraan awam. Terdapat juga kajian lain yang dijalankan iaitu menggunakan serbuk sisa kaca (Md Alimi Bin Yasinan, 2017) namun tidak dapat memenuhi nilai kekuatan mampatan yang tinggi seperti simen. Menurut Ramly, 2007 penggunaan bata bakar menyebabkan peningkatan kos yang tinggi daripada segi penyediaan kos bahan-bahan mentah (Ramly, 2007).

Oleh itu, kajian ini dijalankan dengan tujuan menghasilkan bata ubahsuai tanpa bakar dengan menggantikan separa simen dengan Abu Tongkol Jagung yang mana berkemungkinan mempunyai kekuatan mampatan serta berketumpatan yang baik dan dapat menghasilkan bata yang berkonsepkan kehijauan dalam persekitaran yang mampan. Tongkol jagung diperolehi daripada kilang di sekitar Tanjong Karang, Kuala Lumpur dan Seremban. Peratus yang digunakan untuk bata ubahsuai ialah 10% dan 50% Abu Tongkol Jagung.

2. SOROTAN KAJIAN

2.1 Tanah

Tanah merupakan bahan mineral yang terletak di antara lapisan permukaan bumi dan lapisan tanah tak telap air dalam permukaan bumi. Dalam penghasilan bata, tanah berbutir adalah tanah yang paling sesuai untuk diadun bersama simen dan mengurangkan penggunaan simen. Bahan organik yang terkandung dalam tanah, biasanya bersifat asid dan ini boleh mengganggu proses hidrasi simen yang boleh menyebabkan kekuatan simen terganggu (Taylor, 2002). Maka kandungan bahan organik dalam tanah yang hendak distabilkan mestilah tidak lebih daripada 2%. Menurut Walker dan Stace, 1997 tanah yang mengandungi kandungan mineral kurang daripada 15% hingga 30% adalah yang paling sesuai untuk distabilkan dengan simen pada kadar 5% hingga 10%.

2.2 Pasir

Menurut Tan (2002), pasir boleh didapati daripada lombong atau sungai. Pasir lombong ialah pasir yang digali daripada lombong. Pasir ini banyak digunakan dan biasanya dibahagikan kepada dua jenis, iaitu pasir halus dan pasir kasar. Pasir halus yang mengandungi sedikit tanah, biasanya digunakan untuk bancuhan mortar bersama-sama pasir halus dari sungai dan simen. Bancuhan tersebut menghasilkan mortar yang bersifat plastik dan mudah merekat walaupun kekuatannya agak kurang. Pasir kasar pula sesuai digunakan untuk membancuh konkrit dan membuat blok dan bata simen. Mutu pasir lombong dapat dipertingkatkan dengan membersihkan kandungan tanahnya dengan air. Menurut Tan (2002), pasir sungai mutunya baik jika tidak mengandungi kekotoran yang berlebihan. Bancuhan konkrit atau mortar yang menggunakan pasir sungai sahaja biasanya lebih susah dikerjakan. Oleh itu bahan tambah yang dinamakan pemudah-adun kadangkala digunakan untuk meningkatkan kebolehkerjaan.

2.3 Simen

Simen Portland biasa merupakan campuran batu kapur dan tanah liat yang dibakar bersama dan membentuk kalsium silikat untuk mengawal kadar pengerasan simen semasa bertindakbalas dengan air(Mahyudin Ramli, 1991). Technical Teachers Training Institute (2005) simen Portland biasa sering digunakan dalam pembinaan kerana sifatnya yang bebas terhadap serangan sulfat serta mempunyai rintangan terhadap pengecutan dan keretakan namun agak lemah terhadap serangan kimia.

2.4 Air

Air memainkan peranan penting untuk bertindakbalas dengan simen dalam pembentukan konkrit. Air dari sumber bersih (Taylor, 2002) dan (Mat Lazim, 2005) serta bebas dari kekotoran dan bahan organik (Irving Kett, 2000) perlu digunakan ketika membancuh konkrit bagi menjaga kualiti .

2.5 Abu Tongkol Jagung

Jagung merupakan tanaman ketiga paling utama dunia selepas gandum dan padi (Ghizan Saleh, 2017) serta merupakan tanaman utama di 25 buah negara. Tongkol jagung mudah diperolehi kerana penanaman jagung di Malaysia mempunyai keluasan sebanyak 6,300 hingga 6,800 hektar CHE setiap tahun (Mohd Anim Hosnan, 2019). Penghasilannya juga singkat sekitar 68 hingga 72 hari dan dapat menghasilkan lebih kurang 40,000 tongkol jagung bagi seekar tanah.

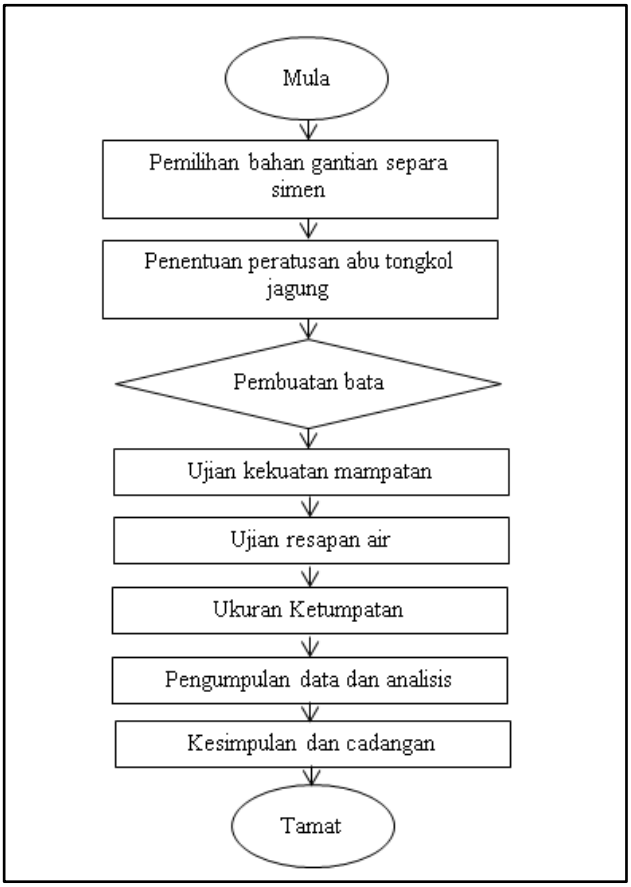
Dalam kegiatan industri, jagung menghasilkan sisa buangan seperti kulit dan tongkol jagung. Sisa tongkol jagung jarang diguna semula dan hanya tertumpu sebagai makanan binatang (Anggraeny, 2006). Pada dasarnya industri tongkol jagung meluas tetapi tidak dimanfaatkan dengan optimal. Tongkol jagung memiliki kandungan silika melebihi 60% (Adesanya dan Raheem, 2009) dan alumina yang tinggi sehingga dapat dimanfaatkan sebagai bahan tambah refraktori. Abu tongkol jagung yang dibakar pada suhu dan waktu tertentu akan menghasilkan butiran abu tongkol jagung yang halus sehingga dapat menyatu dengan mudah bersama bahan-bahan lain dalam bata tanah liat tanpa bakar.

Estu Yoga Elmi Gesa, Yuike Ika Cahyo dan Lucky Caeser Direstiyani (2015) dalam kajiannya menggunakan abu tongkol jagung sebagai gam epoxy. Keputusan eksperimen menunjukkan kenaikan kekuatan mampatan dalam bata yang menggunakan 6% abu tongkol jagung menggantikan simen (Ogunbode dan Apeh, 2012). Penggantian abu tongkol jagung sebanyak 20% dan 50% dari berat simen Portland biasa dalam penghasilan konkrit dan mortar mampu meningkatkan kekuatan, mengurangkan resapan air dan keberaliran haba (Adesanya, 1996). Penggantian 8% abu tongkol jagung mencukupi bagi meningkatkan kekuatan mampatan dalam campuran konkrit (Adesanya dan Raheem, 2009)

Dengan penambahan silika daripada abu tongkol jagung, maka kekuatan impak serta kekuatan bata tanah liat tanpa bakar akan meningkat. Hal ini disebabkan kerana partikel serbuk terikat dengan lebih baik sehingga liang-liang menjadi semakin berkurang yang akan menyebabkan bata tanah liat tanpa bakar tahan terhadap pengikisan, kebolehtelapan menurun, kapasiti panas menjadi lebih tinggi dan konduktiviti termal menjadi lebih baik serta tidak ada konsentrasi tegangan yang akan mengakibatkan keretakan ketika dikenakan beban.

3. METODOLOGI KAJIAN

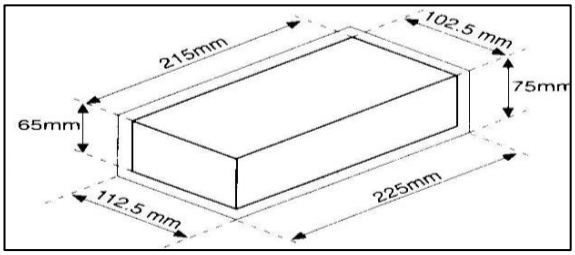
Pengumpulan tongkol jagung diperolehi daripada beberapa pengusaha tanaman jagung dan peniaga-peniaga di sekitar Tanjong Karang, Kuala Lumpur dan Seremban. Tongkol jagung dikumpul sebanyak 6 guni mengikut anggaran kasar yang dibuat untuk menghasilkan 2 kilogram abu tongkol jagung.. Peratus yang digunakan untuk bata ubahsuai ialah 10% dan 50% abu tongkol jagung daripada berat simen Portland biasa. Rajah 1 menunjukkan carta alir proses perlaksanaan kajian ini.



Rajah 1: Carta Alir Proses Perlaksanaan Kajian

3.1 Spesifikasi Bata

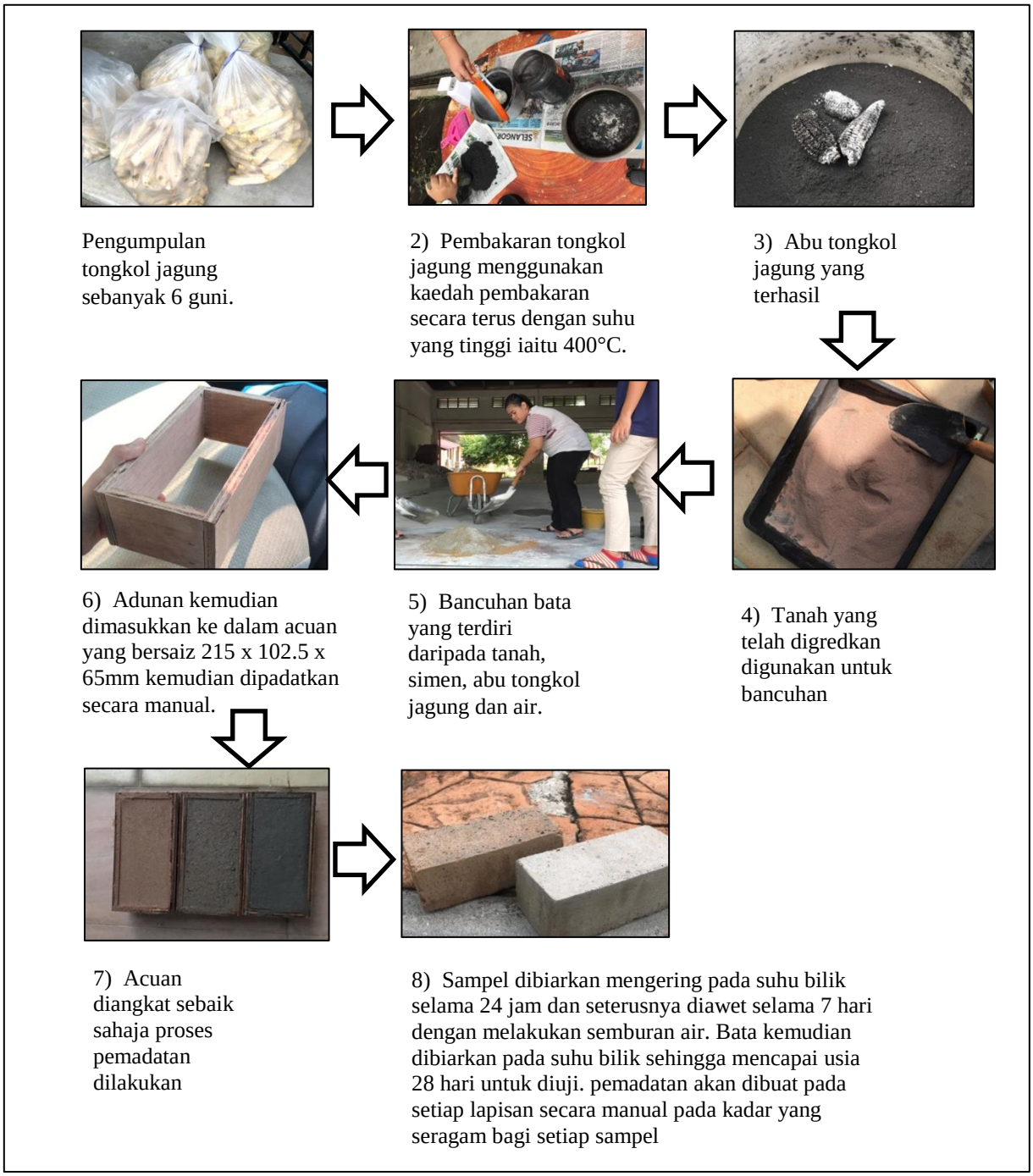
Bata yang dihasilkan akan menggunakan acuan bersaiz 215mm x 102.5mm x 65mm. Rajah 2 menunjukkan lakaran bagi ukuran bata yang dihasilkan.



Rajah 2: Spesifikasi Bata yang Dihasilkan

3.2 Penyediaan bahan dan pembuatan bata

Proses bancuhan dan pembuatan bata dilakukan di bengkel bata dengan mengunakan kaedah manual. Rajah 3 menunjukkan proses pembuatan bata.



Rajah 3: Proses Penyediaan Bahan dan Pembuatan Bata

3.3 Sampel Kajian

Kaedah persampelan adalah mengikut prosedur persampelan bata ubahsuai iaitu pada kadar 18% simen: 41% tanah: 41% pasir (Muhammad Waridi, 2015). Sebanyak 0%, 10% dan 50% abu tongkol jagung digunakan bagi menggantikan peratus simen dalam bancuhan bata. Berdasarkan kajian lepas, kedua-dua peratusan ini paling efektif digunakan bersama-sama simen. Jadual 1 menunjukkan nisbah bancuhan bata menggunakan abu tongkol jagung sebagai gantian separa simen. Setiap bancuhan disediakan 3 sampel untuk mendapatkan purata setiap nilai.

Jadual 1: Kandungan Abu Tongkol Jagung dalam Bancuhan Bata

Kandungan abu tongkol jagung dalam simen	Simen (g)	Tanah (g)	*Pasir (g)*	Abu Tongkol Jagung (g)
0%	1980	4950	*4950*	0
10%	1782	4950	*4950*	198
50%	990	4950	*4950*	990

3.4 Ujian Kekuatan Mampatan

Ujian kekuatan mampatan dilaksanakan berdasarkan BS 3921 (1985) menggunakan tiga sampel. Bata ini direndam selama 16 jam dengan suhu air antara 10°c hingga 25°c di dalam sebuah bekas air. Sampel bata tersebut di keluarkan dari tangki dan dikeringkan selama setengah jam pada suhu bilik. Guni basah digunakan untuk menutup permukaan atas bata bagi mengelakkan kehilangan lembapan semasa proses pengeringan. Kemudian, sampel bata diuji menggunakan mesin mampatan. Rajah 4 menunjukkan proses perlaksanaan kekuatan mampatan terhadap bata yang telah direndam selama 16 jam.

Rajah 4: Ujian Kekuatan Mampatan Yang Dilakukan Di Makmal Kejuruteraan

3.5 Penentuan Ketumpatan

Sampel bata dikeringkan didalam oven pada suhu 100°C dalam tempoh 24 jam ketumpatannya dikira menggunakan persamaan :

Ketumpatan = Jisim/Isipadu

3.6 Ujian Resapan Air

Sampel bata kawalan dan bata abu tongkol jagung diuji untuk mengetahui kadar resapan air bagi menentukan tahap ketahanlasakan bata tersebut. Ujian resapan air yang dilakukan mengikut BS 1881-122: 2011. Kadar resapan akan diuji dengan menggunakan 3 sampel bagi setiap bancuhan. Sampel dibiarkan dalam oven dengan suhu 110 °C selama 48 jam. Kemudian dibiarkan selama 4 jam dalam suhu bilik dan berat kering, W_1 ditimbang. Bata diletakkan dalam tangki dan dibiarkan selama 24 jam dan ditimbang sebagai W_2. Peratus serapan air dikira menggunakan persamaan 1.

Persamaan 1: % Resapan air = $(W_2-W_1)/W_1$ X 100

4. ANALISIS DAN KEPUTUSAN

4.1 Kekuatan Mampatan

Kekuatan mampatan sesuatu bata banyak dipengaruhi oleh kandungan simen dalam bancuhan, jenis bahan mentah sesuatu bata dan teknik pemadatan yang digunakan. Kekuatan mampatan adalah merupakan satu aspek yang penting dalam menilai kemampuan tanggung beban sesuatu bata.

Daripada Jadual 2 didapati bahawa bata kawalan mencatatkan purata kekuatan mampatan 5.50 N/mm² dengan keputusan kekuatan mampatan tertinggi 5.55 N/mm² manakala yang terendah adalah 5.46 N/mm². Penggunaan Abu Tongkol Jagung sebanyak 10% menghasilkan keputusan kekuatan mampatan purata sebanyak 5.78 N/mm². Keputusan terendah bata ini adalah 5.75 N/mm² dan kekuatan mampatan tertinggi adalah 5.80 N/mm². Penggunaan Abu Tongkol Jagung sebanyak 50% menghasilkan kekuatan mampatan purata bata adalah 5.95 N/mm². Kekuatan mampatan tertinggi adalah 6.05 N/mm² dan terendah adalah 5.84 N/mm².

Menurut Compressed Earth blocks Standards (1998) kekuatan mampatan terendam bata yang dihasilkan dengan menggunakan tanah biasanya berada dalam lingkungan 4 N/mm² ke bawah dan mencukupi untuk digunakan sebagai struktur yang rendah bebanannya seperti kediaman setingkat. Perbezaan kekuatan ini wujud disebabkan daripada penggunaan tanah yang berbeza semasa proses penghasilannya dan juga cara pemadatannya. JKR Standard Specifications For Building Works, 2005 menetapkan kekuatan mampatan bata adalah 5.20 N/mm^2.

Jadual 2: Keputusan Ujian Mampatan

Kandungan abu tongkol jagung dalam simen	Kekuatan (N/mm²)			
	Sampel 1	Sampel 2	Sampel 3	Purata
0%	5.48	5.55	5.46	5.50
10%	5.80	5.78	5.75	5.78
50%	6.05	5.95	5.84	5.95

4.2 Ketumpatan

Jadual 3 menunjukkan keputusan pengukuran ketumpatan bagi bata kawalan dan bata ubahsuai menggunakan Abu Tongkol Jagung. Daripada data, menunjukkan bacaan yang diperolehi adalah agak seragam. Ini menunjukkan proses penghasilan bata yang dilakukan adalah konsisten. Secara puratanya ketumpatan bagi bata kawalan adalah 1834 kg/m³. Manakala ketumpatan purata bagi bata yang telah diubahsuai dengan Abu Tongkol Jagung adalah 1793 kg/m³dan 1764 kg/m³.Berdasarkan kebanyakan kajian lepas, ketumpatan bata tanah adalah di antara 1500 kg/m³ dan 2000 kg/m³. Hasil kajian ini secara amnya memenuhi piawai yang digunakan malah agak ringan berbanding bata kawalan yang menggunakan lebih banyak simen. Analisis terhadap Rajah 5 mendapati semakin tinggi penggunaan Abu Tongkol Jagung semakin tinggi kekuatan mampatan dan semakin rendah ketumpatannya. Ini menunjukkan Abu Tongkol Jagung sesuai dijadikan sebagai bahan alternatif menggantikan simen.

Jadual 3: Keputusan Pengukuran Ketumpatan

Kandungan abu tongkol jagung dalam simen	Ketumpatan (kg/m³)			
	Sampel 1	Sampel 2	Sampel 3	purata
0%	1857	1837	1809	1834
10%	1843	1822	1715	1793
50%	1781	1799	1712	1764

4.3 Ketahanlasakan

Keputusan analisis kebolehresapan air pada bata kawalan dan bata ubahsuai abu tongkol jagung ditunjukkan Jadual 4. Sampel bata yang mengandungi komposisi abu tongkol jagung 10% dan 50% mempunyai kerintangan yang lebih baik daripada sampel bata tanpa abu tongkol jagung terhadap ujian peresapan air.

Jadual 4: Keputusan Ujian Kadar Serapan Lembapan

Jenis bata	Sampel	W_1(kg)	W_2(kg)	(W_2 -W_1)	Serapan Lempaban %	Purata %
Bata kawalan	1	2.81	3.12	0.31	11.03	7.76
	2	2.79	2.98	0.19	6.81	
	3	2.76	2.91	0.15	5.43	

Bata CCA (10%)	1	2.73	2.80	0.08	2.93	3.49
	2	2.80	2.91	0.11	3.92	
	3	2.76	2.86	0.10	3.62	
Bata CCA (50%)	1	2.78	2.85	0.07	2.51	1.69
	2	2.68	2.70	0.02	0.75	
	3	2.74	2.79	0.05	1.82	

5. KESIMPULAN

Berdasarkan kajian yang dijalankan melalui ujian makmal, didapati bata dengan bahan gentian 10% dan 50% abu tongkol jagung mencatatkan kekuatan mampatan melebihi bata tanpa abu tongkol jagung iaitu 5.78 N/mm² dan 5.95 N/mm². Dari segi ketumpatan ianya lebih ringan dan kadar resapan lembapan bagi 10% dan 50% bata abu tongkol jagung juga berada pada tahap yang memuaskan dan sesuai untuk penggunaannya. Bata dengan kekuatan 5.2 N/mm² boleh digunakan dalam pembinaan rumah satu atau dua tingkat.

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SMART WATER SOLUTION

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ABSTRAK

Air merupakan komponen penting dalam kehidupan manusia dan hidupan air. Air perlu diuruskan dengan baik selaras dengan pertambahan penduduk dan perkembangan ekonomi. Amalan kitar semula kurang dipraktikkan di kalangan masyarakat. Peningkatan pencemaran alam meningkat berikutan pertambahan populasi penduduk semakin meningkat maka bahan dan sisa buangan terhasil. Pembuangan sampah dan sisa pepejal ke dalam sistem saliran semakin meningkat dan mengalir bersama air yang masuk ke dalam tasik seterusnya menyumbang kepada penurunan kualiti air bersih. Tasik seringkali mengeluarkan bau tidak menyenangkan terutama waktu pagi dan hari cerah. Kekeruhan dan pertumbuhan alga serta tumbuhan akuatik turut menjadi punca pencemaran. Objektif kajian ialah menghasilkan satu produk yang mampu menyelesaikan masalah tasik tercemar. Seterusnya menentukan nilai parameter-parameter air tasik di Taman Tasik Jaya yang dikaji berdasarkan Indeks Kualiti Air,. Penyelesaian efektif ialah menghasilkan produk Smart Water Solution dengan campuran bahan organik (EM), kulit pisang dan dedak beras yang mampu merawat pencemaran air. Produk ini merawat keadaan air yang dicemari serta oksigen dalam air ditingkatkan untuk kepentingan hidupan di dalam air. Smart Water Solution menggunakan 50% kulit pisang dan 50% dedak beras (sampel 1) serta 30% kulit pisang dan 70% dedak beras (sampel 2) . Dapatan kajian menunjukkan Smart Water Solution berkesan mengurangkan beberapa jenis pencemaran dan berjaya meningkatkan kelas keseluruhan tasik. Dengan merujuk 5 data parameter kepada Indeks Kualiti Air, kelas keseluruhan tasik ini bertambah baik dari Kelas III hingga Kelas II. Bagi mengelakkan fenomena eutrofikasi berlaku lebih cepat, langkah-langkah kawalan dan pemuliharaan perlu dilaksanakan segera untuk menghentikan atau mengurangkan peluang tasik mengalami proses eutrofikasi.

KATA KUNCI: *EM, Mudball, penjernihan sungai*

1. PENGENALAN

Air adalah pemberi nyawa bahkan pencipta kehidupan yang bernyawa di muka bumi ini. Dua pertiga pemukaan bumi diliputi oleh air dan tubuh manusia terdiri daripada 75 peratus air. Air beredar di muka bumi sebagaimana yang dilakukan di dalam tubuh manusia iaitu mengangkut, membubarkan, menambahkan semula nutrien dan bahan organik serta membawa bersama bahan buangan. Indeks Kualiti Air umumnya merupakan cara mudah dan ringkas untuk menentukan kualiti air, dengan melihat pelbagai parameter utama kualiti air yang digabungkan untuk mewakili kuantiti air keseluruhan jasad air. Kini, amalan kitar semula kurang dipraktikkan di kalangan masyarakat menyebabkan meningkatnya pencemaran alam selaras dengan pertambahan populasi penduduk maka bahan dan sisa buangan telah dihasilkan. Pembuangan sampah sarap dan sisa pepejal menerusi sistem saliran semakin meningkat dan seterusnya mengalir bersama air yang masuk ke dalam tasik menjadi salah satu penyumbang kepada penurunan kualiti air bersih. Selain itu, terdapat juga bahan organik dan bukan organik disalurkan menerusi sisa-sisa penggunaan aktiviti harian manusia. Hasil lawatan lapangan ,terdapat beberapa masalah dikesan di kawasan tasik. Antaranya masalah bau yang tidak menyenangkan dari tasik, terutama waktu pagi dan hari yang cerah. Keadaan air tasik juga kelihatan keruh serta berwarna kehijauan dan dapat dilihat pertumbuhan alga dan tumbuh-tumbuhan akuatik di dalam tasik.Keadaan ini sedikit sebanyak menyumbang kepada pencemaran di tasik ini. Seterusnya oksigen di dalam air berkurangan hingga mengakibatkan tumbuhan

dan haiwan mati kerana kekurangan sumber asas yang utama. 'Smart Water Solution' dihasilkan untuk merawat keadaan air yang dicemari serta meningkatkan oksigen di dalam air demi kepentingan kehidupan yang hidup di dalam air.

Effective Microorganism (EM) ialah terdiri daripada buangan dan bahan kitar semula serta selamat untuk alam sekitar dan hidupan yang terdapat di dalam tasik. Penerapan teknologi *EM* merupakan suatu teknologi alternatif meningkatkan kualiti alam. Produk *'Smart Water Solution'* ini dihasilkan dalam bentuk bebola leper dan dapat mengkaji parameter-parameter air iaitu tahap kekeruhan air, *Dissolved Oxygen Demand (B.O.D)*, kadar PH air, suhu dan Jumlah Pepejal terampai (T.S.S) dan *Chemical Oxygen Demand (C.O.D)*. *Mudball* adalah campuran tanah liat, bahan organik ,molasses,minerals dan gabungan bakteria berfaedah iaitu Laktik Asid bakteria, Fototropik bakteria, yis dan Antinomycetes. *Mudball* diformulakan untuk kesesuaian kes atau persekitaran iaitu mudah dilontar dan tenggelam di dalam air serta bertindak perlahan-lahan dari dasar air bertujuan memecahkan molekul-molekul organic seperti sisa-sisa sampah, lumpur, logam berat dan sebagainya. Dalam keadaan tertentu tindakbalas *mudball* banyak digunakan dalam rawatan air, namun kini penggunaannya semakin meluas untuk ternakan air (akuakultur) bertujuan menjaga kualiti air dan menyeimbangkan mikroflora air. Dengan aplikasinya yang mudah, mudball amat sesuai dan praktikal sebagai stok yang patut bagi membantu menguruskan air (Fauzi, 2002).

2. SOROTAN KAJIAN DAN PEMBINAAN HIPOTESIS

'Smart Water Solution' kajian kami terhasil daripada campuran tiga jenis bahan iaitu dedak beras, cecair EM dan tanah merah. Penggunaan asid laktik yang merupakan sebatian organik memainkan peranan dalam beberapa proses biokimia.

2.1 Cecair *Effective Microorganism (EM)*

EM terdiri daripada bakteria bermanfaat yang digunakan untuk tujuan mencegah penyakit seperti pertumbuhan bakteria patogen, dan meningkatkan kecekapan pengambilan bahan organik. EM boleh mencegah pembentukan tindak balas kimia bakteria yang tidak bermanfaat yang akan membantu dalam meningkatkan mikrobiologi alam sekitar yang membawa kepada persekitaran yang sihat. Bakteria dalam penyelesaian EM boleh meningkatkan oksigen terlarut (DO), menstabilkan pH dalam air, mengurangkan bau, mengurangkan nutrien di kolam, mengurangkan sedimen atau enapcemar di kolam, menurunkan tahap permintaan oksigen biokimia (BOD) dan permintaan oksigen kimia (COD), mengurangkan tahap penghasilan gas hidrogen sulfida, mengurangkan tahap bahan organik di dalam air, mengurangkan tahap besi dan mangan, dan meningkatkan tahap kekeruhan. Komposisi Mikroorganisma Berkesan (EM) terdiri daripada bakteria asid laktik (LAB), bakteria fotosintetik (PsB) dan yis. Apabila ketiga-tiga bakteria ini bercampur dengan bahan organik, sebatian bermanfaat seperti vitamin, hormon, enzim, asid organik, mineral dan pelbagai anti-oksida akan dihasilkan.

2.1.1 Jenis-jenis EM.

EM adalah gabungan *beneficial micro-organisms* yang telah dimajukan oleh Professor Teruo Higa di Universiti Of The Ryukyu Japan. Mikroorganisma ini telah menyuburkan tanah, tanaman, air dan kesihatan manusia dengan cara mereputkan bahan bahan organik dalam tanah, menggunakan nitrogen di udara dan menjadi makanan tanaman dan haiwan disamping melindungi nya daripada ancaman penyakit. Mikroorganisma tersebut terdiri daripada ragi utama, pro-biotik atau bakteria fotosintesis dan bakteria asid laktik..

Di Asia EM telah diproses hingga menjadi empat jenis *EM (EM1*, *EM2*, *EM3* dan *EM4)*. *EM2* mengandungi lebih mikroorganisma daripada *EM1*. Mikroorganisma ini wujud sebagai satu konsortium. Mikrob yang wujud dalam EM2 adalah bakteria fotosintesis, fungi, yis atau acuan dan sebagainya. EM2 dikultur dalam cecair dengan ph7 dan disimpan pada ph 8.5. Populasi mikroorganisma dalam cecair dianggarkan 1 billion cells/gram cecair. EM2 mengandungi 90% bakteria fotosintesis dan bakinya adalah mikroorganisma. EM3 dikultur dalam medium cecair dan disimpan pada ph 8.5. Populasi mikroorganisma dalam cecair adalah 1 billion cells/gram cecair. EM4 mengandungi 90% lactobacisslus dan mikroorganisma yang menghasilkan lebih asid laktik. EM4 dikultur dalam medium cecair dengan kandungan ph 4.5. Populasi mikroorganisma adalah sama saperti diatas. 1 billion cells/gram cecair. Perbezaan diantara EM1, EM2, EM3 dan EM4 ialah bilangan kandungan mikroorganisma yang terdapat di dalamnya. Jenis yang terbanyak diguna di Asia bagi memajukan pertanian dan perikanan adalah EM4.

2.2 Mudball

Mudball digunakan untuk bakteria anaerobik di bahagian bawah kolam. Mudball terdiri daripada tiga generik utama mikrob bakteria fototropik, bakteria asid laktik dan yis. Mikroorganisma adalah (mikroba yang bermanfaat) yang diasaskan oleh ahli hortikultur dari Jepun yang mempunyai penyelidikan Dr. Higa & Dr. Teruo paling banyak kualiti mikrob semula jadi sejak tahun 1970 dan pada tahun 1980 beliau mengasaskan EM.

2.3 Tanah

Tanah adalah bahagian permukaan bumi yang terdiri daripada mineral dan bahan organik. Tanah sangat penting peranannya bagi semua kehidupan di bumi, kerana tanah mampu mendukung kehidupan tumbuhan di mana tumbuhan menyediakan makanan dan oksigen kemudian menyerap karbon dioksida dan nitrogen.

2.3.1 Komposisi tanah berbeza-beza pada satu lokasi dengan lokasi yang lain. Tanah yang terdiri dari pedosfera, terletak di antara muka litosfera dengan biosfera, atmosfera and hidrosfera. Pembentukan tanah, atau pedogenesis, merupakan kesan gabungan proses fizikal, kimia, biologi dan antropogen pada bahan asal geologi yang menghasilkan lapisan tanah. Di Malaysia terdapat pelbagai jenis tanah, antaranya ialah tanah Organosol, tanah Aluvial, tanah Regosol, tanah Litosol, tanah Latosol ,tanah Grumusol ,tanah Podsolik, tanah Podsol, tanah Andosol, tanah Merah Kuning Mediterranean dan kelabu Hydromorph .

2.3.2 Tanah juga mempunya pelbagai sifat. Antaranya ialah warna tanah yang dipengaruhi oleh kandungan organik atau kimia. Secara umum, tanah dengan banyak kandungan organik akan berwarna gelap, dan mempunyai kadar kesuburan yang cukup tinggi. Tekstur tanah adalah saiz granul tanah, di mana kita dapat membezakan tekstur ini menjadi 3 kelas iaitu pasir, tanah liat dan tanah liat. Tekstur tanah yang baik adalah tanah liat dengan perbandingan antara pasir, debu dan tanah liat mestilah sama, jadi tanah itu tidak terlalu longgar dan tidak melekit.

Struktur Tanah adalah susunan butiran tanah, di mana kita boleh membezakan struktur-struktur ini menjadi 3 jenis, iaitu struktur butiran longgar, struktur remah, dan struktur yang kental. Tanah dikatakan memiliki struktur butir longgar, jika biji-bijian tanah bertaburan atau terpisah dari satu sama lain, sedangkan tanahnya rapuh apabila biji-bijian tanah berkumpul untuk membentuk sejenis kerak roti. Struktur sampah adalah struktur tanah yang terbaik untuk digunakan sebagai tanah pertanian. Struktur tanah yang terkumpul dicirikan oleh bijirin tanah yang dipasang rapat antara satu sama lain. Tahap keasidan (pH) tanah. apabila dilihat dari tahap keasaman, tanah itu berasid, dan ada yang alkali dan ada yang neutral. Keasaman ini boleh berlaku kerana tanah sentiasa dibanjiri. Dan pada amnya akar tumbuhan akan rosak jika tanah terlalu asid atau terlalu beralkali. Secara amnya tumbuhan memerlukan pH tanah neutral. Di permukaan bumi, tanah atau tanah mempunyai kebolehan yang berlainan.

2.4 Dedak beras

Dedak adalah hasil sampingan proses penggilingan beras. Dedak beras terdiri daripada lapisan luar bijirin padi (perikap dan tegmen), manakala dedak terdiri daripada lapisan dalam bijirin beras, iaitu aleurone atau sekam padi dan sebahagian kecil endosperm. Karbohidrat utama dalam dedak beras ialah hemiselulosa, selulosa, kanji dan b-glucan. Tiga asid lemak utama dalam bran dan bran padi adalah palmitik, oleik dan linoleik. Minyak bran beras mentah mengandungi lilin 3 hingga 4 peratus dan kira-kira 4 peratus daripada lipid yang tidak saponifikasi. Antioksidan yang berpotensi seperti oryzanol dan vitamin E juga terdapat dalam dedak beras. Bran dan dedak beras juga kaya dengan vitamin B kompleks.

2.5 Kulit pisang

Kulit pisang terdiri daripada atom nitrogen, sulfur dan bahan organik seperti asid karboksilik. Asid ini boleh mengikat logam di dalam air, kata Gustavo Castro, seorang penyelidik dari University of Sao Paulo. Para penyelidik mendapati kepingan kulit pisang dapat memimpin dan tembaga dari air di sungai Parana, Brazil. Menurut mereka, pembersih dari kulit pisang boleh digunakan sehingga 11 kali. Bahan sintetik boleh digunakan beberapa kali, tetapi bahan semulajadi jauh lebih murah dan tidak memerlukan proses kimia untuk membuatnya. Secara umumnya, kulit pisang mengandungi banyak karbohidrat, air, vitamin C, kalium, lutein, antioksidan, kalsium, vitamin B, lemak, protein, pelbagai vitamin B kompleks termasuk vitamin B6, minyak sayuran, seratonin dan banyak lagi. Kulit pisang mempunyai banyak manfaat dalam kehidupan, termasuk sebagai pembersih air. Kulit di dalam pisang mengandungi beberapa komponen biokimia, termasuk selulosa, hemiselulosa, pigmen klorofil dan bahan pektin yang mengandungi asid galakturonik, arabinose, galaktosa dan rhamnosa. Asid Galacturonic menyebabkan kuat untuk mengikat ion logam yang merupakan kumpulan berfungsi gula karboksil. Berdasarkan hasil kajian, selulosa juga membolehkan pengikatan logam berat (Bankxian, 2014).

3. METODOLOGI KAJIAN

3.1 Proses membuat cecair *EM*

Cecair *EM* adalah bahan penting untuk membuat mudball. Dalam cecair *EM* terdapat banyak bakteria baik yang dapat membantu untuk membersihkan air.

CARTA ALIR PENGHASILAN CECAIR *EM*

Basuh beras (dengan air tanpa klorin), ambil airnya. Simpan dalam bekas atau botol dan tutup.

Peram air beras selama 3 ke 5 hari. Peraman akan siap bila air berbau masam dan menghasilkan 3 lapisan.

Gunakan bekas baru yang lebih besar, masukkan air beras masam bersama dengan susu. (nisbahnya ialah 1 bahagian air beras masam + 10 bahagian susu).

Lepas seminggu, akan terbentuk 2 lapisan. Lapisan atas ialah susu kental manakala lapisan bawah terdiri dari cairan warna kuning cair, kaya dgn bakteria. Tapis untuk asingkan susu kental dgn lacto serum.

Campurkan cecair susu tadi dengan gula perang mengikut sukatan. Nisbah 1:1 (contoh satu 1L cecair susu bersamaan dengan 1kg gula perang).

Rajah 3.1 :Carta Alir Penghasilan Cecair *EM*

3.2 Proses Penghasilan '*Smart Water Solution'*
Smart Water Solution menggunakan empat jenis bahan iaitu kulit pisang, dedak beras, tanah merah, dan cecair *EM*. Rujuk Rajah 3.2. Proses peraman *'Smart Water Solution'* dilakukan bagi melihat pembiakan bakteria Peraman dilakukan selama seminggu. Pada hari ketujuh , terdapat fungus yang membiak begitu banyak pada '*Smart Water Solution'*.

3.3 Ujikaji Parameter Air
3.3.1 Kekeruhan
Ujikaji ini dilakukan untuk mengenalpasti kepekatan kekeruhan sampel air. Selain itu,ujikaji ini juga digunakan untuk menjalankan kaedah ujian yang sesuai untuk ciri fizikal air.Proses ujikaji kekeruhan dilakukan dengan mencuci sel dengan air suling sebelum digunakan. Sampel air diisi ke dalam bikar kemudian sampel air dituang dari bikar ke sel sehingga mencapai garis putih dalam sel. Tahan sel sampel dengan penutup dan lap untuk membuang tempat air dan hujung jari menggunakan kain. Seterusnya letakkan sel sampel ke meter kekeruhan dan tutup penutup. Tekan butang read / timer dan rekod bacaan dalam unit ntu. Dan ulangi langkah di atas dengan sampel air yang lain.

Rajah 3.2 :Carta Alir Penghasilan *'Smart Water Solution'*

3.3.2 Oksigen Terlarut (DO)

Ujikaji ini dilakukan untuk mengenalpasti kepekatan oksigen terlarut sampel air. Selain itu, untuk menjalankan kaedah oksigen terlarut yang sesuai untuk memeriksa kualiti air. Proses menggunakan ujikaji DO dilakukan dengan mengisi sampel air ke dalam bikar.Kemudian, masukkan siasatan DO ke sampel air dalam bikar dan tenggelamkan siasatan iaitu alat DO, sehingga mencapai sampel air.Rekod bacaan diambil dan ulangi langkah di atas dengan sampel air yang lain.

3.3.3 Permintaan Oksigen Biokimia (BOD)

Ujikaji ini dilakukan untuk menentukan jumlah oksigen yang digunakan oleh mikroorganisma. Selain itu,ia dilakukan untuk menjalankan kaedah permintaan oksigen biologi yang sesuai untuk memeriksa kualiti air. Proses ujikaji yang dilakukan ialah dengan mengisi botol BOD dengan sampel air 300 ml. Botol BOD 300 ml khusus direka untuk membolehkan mengisi penuh tanpa ruang udara dan menyediakan meterai kedap udara yang digunakan. Isi satu botol dengan air suling dan ditanda sebagai 'kosong'. Ukur kepekatan DO menggunakan meter DO dan rekod data sebagai DO awal. Kemudian letakkan botol ke dalam inkubator gelap selama lima hari. Selepas lima hari, ukurkan kepekatan DO menggunakan meter DO serta rekod data sebagai DO akhir. Tolak DO akhir dengan DO awal untuk mendapatkan kepekatan BOD.

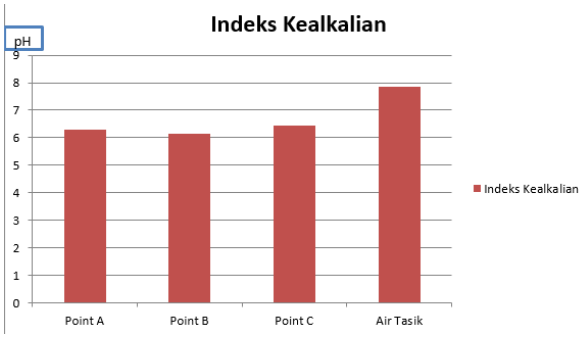
3.3.4 Permintaan Oksigen Kimia (COD)

Ujikaji ini dilakukan untuk menentukan jumlah oksigen yang diperlukan untuk mengoksidakan bahan pencemar atau bahan organik. Selain itu , untuk menjalankan kaedah permintaan oksigen kimia yang sesuai untuk memeriksa kualiti air. Berikut adalah proses ujikaji dilakukan ;

i. Hidupkan fotometer dan panaskan hingga 150 c.
ii. Pilih reagen pencernaan yang sesuai berdasarkan kepekatan sampel air.
iii. Sampel pipet ke reagen penghadaman dan tutup botolnya dengan ketat.
iv. Bilas luar botol dan bersihkan botol dengan kain bersih.
v. Tahan penutup vial dan terbalikkan vial perlahan-lahan beberapa kali untuk mencampurkan kandungan

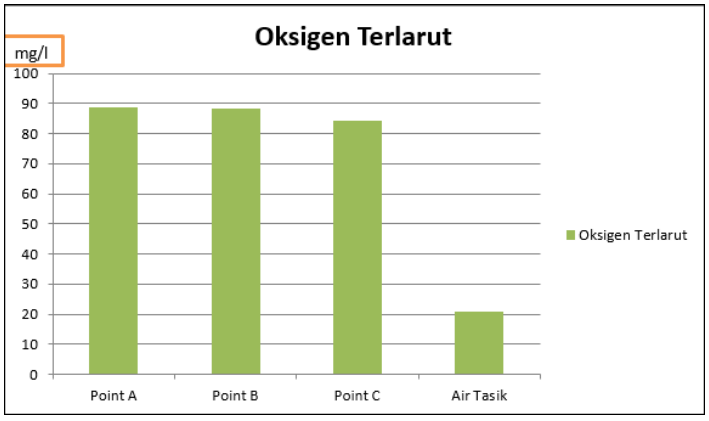
4. ANALISIS DAN KEPUTUSAN

Ujikaji yang telah dilakukan ada 6 kesemua sekali iaitu pH, DO, BOD, COD, pepejal terampai(TSS) dan Ammonia nitrogen. Sampel air yang dianalisis mempunyai tiga data, iaitu sampel sebelum meletakkan Mudball ke dalam takungan, sampel tiga hari selepas meletakkan Mudball dan sampel terakhir pada hari ke tujuh.



Rajah 4 (a) Keputusan indeks kealkalian (pH)

Pengelasan kualiti air berdasarkan Interim Nasional Water Quality Standart (INWQS) oleh Jabatan Alam Sekitar (JAS) menunjukkan bahawa carta pH di atas bersifat asid pada titik A, B dan C, manakala, air tasik bersifat alkali. Hal ini membuktikan bahawa julat 1-6 merupakan bahan yang bersifat asid manakala julat 7 bersifat neutral dan julat 7.5-11 bersifat alkali.



Rajah 4(b) : Keputusan oksigen terlarut

Oksigen terlarut (DO) pada ketiga-tiga titik mempunyai tahap yang hampir sama, manakala air tasik mempunyai tahap oksigen terlarut yang amat rendah.

5. KESIMPULAN

Kaedah rawatan mikroorganisma berkesan (EM) berkesan dalam mengurangkan suhu, permintaan oksigen biokimia (BOD), dan permintaan oksigen kimia (COD). Dengan merujuk data 5 parameter kepada Indeks Kualiti Air, kelas keseluruhan tasik ini juga bertambah baik dari Kelas III hingga Kelas II. Ini menunjukkan Smart water solution berkesan dalam mengurangkan beberapa jenis pencemaran seperti yang dinyatakan sebelum ini. Bukan hanya itu, ia juga berkesan dalam meningkatkan kelas keseluruhan sungai.

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IMPLEMENT KARAKURI AS A MATERIAL HANDLING IN PRODUCTION SEALER LINE

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ABSTRACT

This study was conducted to reduce the waste of motion in production line by implementing material handling method calls as a Karakuri System. The Karakuri has naturally meant that there is no assistance from any energy sources such as electricity, pneumatics, and hydraulics. The waste during motion is the main problem that had caused the work process in production line due to delay. Therefore, a study has been made regarding waste of motion using Standard Work Combination Table (SWCT) as a tool for analysis in order to reduce waste. The concept of Karakuri implements to deliver the tools in good condition without interrupt any process. The expected result of waste can be reduced while increasing the productivity of the company.

Key Words: *Karakuri, Waste, Production Line, Interrupt, Productivity*

1.0 INTRODUCTION

Waste elimination is a major challenge faced by experts in automotive manufacturing industry. Normally, there are seven types of industrial waste in lean systems such as waste of motion, waste of overproduction, , waste of transportation, waste of defect, waste of waiting, waste of inventory and waste of over-processing. Nowadays every organization faces with type of waste which occurs every day expecially in production line activities.In addition, the waste motion involves the working efficiency and time consume on the production line itself. The waste of motion is classified as an unnecessary movements in the manufacturing industry that will cause processing delay (P. Arunagiri and A. Gnanavelbabu, 2014). In order to overcome the waste of motion, method of Karakuri is the tips and tricks for an efficient manufacturing solution in the factories that are, the Jidoka's powerful part (automation with human intelligence). It aims at eliminating the use of machines or fixtures by the human hand (Rani et al. 2015).Rani et al. (2015) also stated that. The word ' Karakuri ' means a mechanical device for teasing, tricking, or surprisingly taking a person. It involves hidden magic or a mystery element. Madisa et al. (2019) stated that Karakuri Kaizen is a Japanese term that can be defined as a mechanism of automation that was introduced and used in Japan during the Edo era. The Karakuri Kaizen technology helps to facilitate objective operations and improves productivity. Figure 1.0 shows the example of Karakuri system.

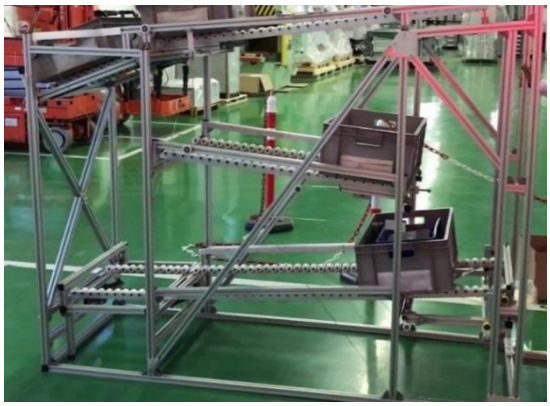

Figure 1.0: Karakuri System

2.0 PROBLEM STATEMENT

In the sealer production line at the paint shop department,the sealer process consume huge time to complete a process which involve an operator to walk while transfer the door stopper causes increase the process of cycle time. This is because the process that should have done has been mixed with the problems that are often encountered. At the second station in the sealer production line, is the process of applying sealer on the door of the car body as shown in Figure 2.0. The door stopper fixture has been used in the seconds' station as a stopper to ensure the door did not close during the applying sealer, and the door stopper fixture used until the fourth station by following the conveyer movement in the sealer production line as shown in Figure 2.1.

Figure 2.0: Process apply sealer line on the door

Figure 2.1: Door stopper fixture follows the conveyor movement

The problem encountered in the production sealer line of the paint shop department is that the excess door stopper fixture Figure 2.3, which has been used, has to be put on the forth station in the sealer production line . The operator at the forth station is required to send all the door stopper fixtures by walking for 24 meters in repeating as shown in Figure 2.4, to the second station in the production sealer line. By doing the repeating walking for 24 meters, it will disturb the cycle time for the process, and also disturbed the tact time of the whole process. Therefore, this study is needed by designing the material handling to ease the process flow and reducing the waste of motion so that the operator does not need to deliver door stopper fixture by walking for 24 meters.

Figure 2.3: Door stopper fixture in the fourth station

Figure 2.4:Operator walks to send the door stopper fixture

3. 0 RESEARCH OBJECTIVES

The objective of this study is:

i. To design the roller rack using Karakuri concept as material handling to be used in the production sealer line.
ii. To analyze the waste of motion using standardized work combination table.

4. 0 METHODOLOGY

4.1 Design

The design has involved the Computer-aided design (CAD) is a family computing system intended to facilitate complex design activities. Parametric modeling is one of the current industrial forces in a CAD system, particularly in engineering.The designs generated from the ideas obtained from the problems that occur make every item in the design detailed. By issuing quantitative such as simulation, measurement, and formula all of these can meet the design of requirements The intended quantitative is the appropriate measurement design associated with the formula regarding the concept of Karakuri. The concept of Karakuri is taken into account in terms of durability, safety, and load reduction.

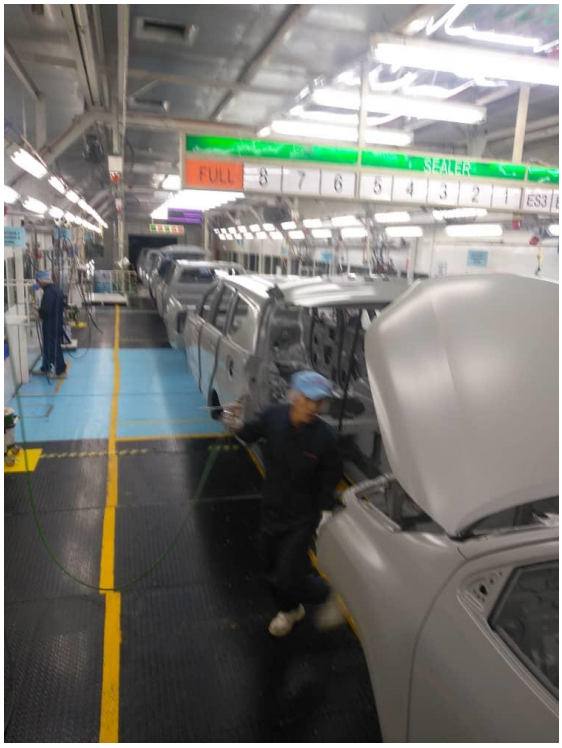

Figure 4.1: Sealer production line

Measurements are carried out at the sealer production line for length at each station is 4 meters. There are 5 stations, therefore the total length is 20 meters. This measurement is important in order to developed the Karakuri concept at the design development stage . Figure 4.1 shows the length of a sealer production line.

4.2 Strategy Planning Design

The Karakuri concept will be applied by considering the space of the production line without interrupt any of process flow by the operator during the sealer process. The study has been done to reduce the waste of motion operators with the condition of the production line itself. In addition the Karakuri system is smaller in term of dimension and it is suitable to placed at the production sealer production line . By purposed a drawing plan, such as a plan layout, the idea of making this Karakuri and also with the calculation of theorytical is convincing and move smoothly with all the strategies and planning have been made as the Figure 4.1.1 show below.

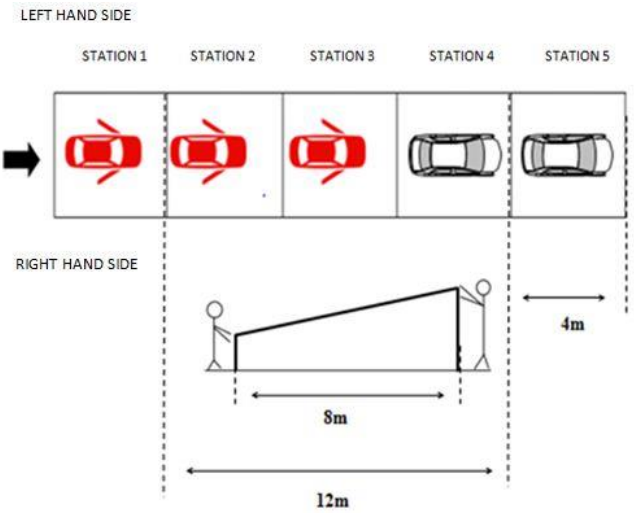

Figure 4.1.1:Draw a plan layout to get the idea

4.2.1 Selection of Design

For the next method is selection of design based on space and suitability.This is because the limited space will caused the disruption of the process and effect of the cycle time.The Karakuri concept is design by considered in terms of cost and space. The cost to produce Karakuri design should be less waste, cheap and affordable as well as is simple . The Karakuri design need to be simple in order to allow the implementation method to be easy and the research is to be done smoothly. Figure 4.1.2 shows the chosen Karakuri simple concepts in sealer production line .

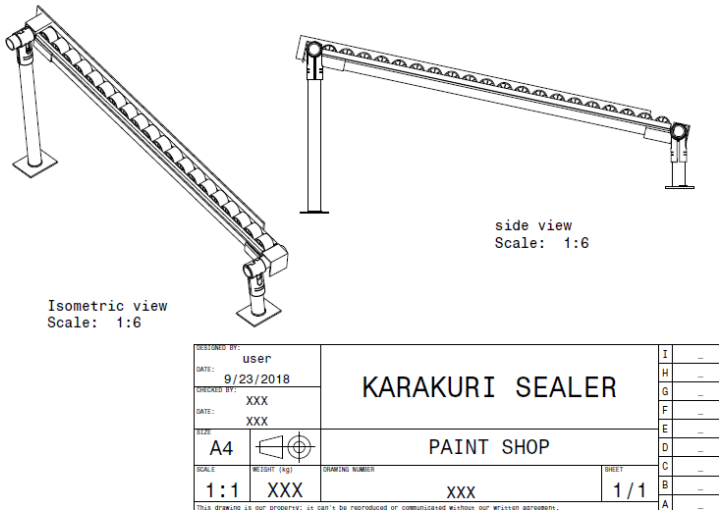

Figure 4.1.2:Selection of Karakuri concept in Sealer production line

4.2 Implementation the Karakuri Rack

Implementation method is the next step after the selection of design is finalize by considering the derivation from the selection such as less waste, less cost and give a profitable to a company. Initially, this method is implement by obtaining the size and required measurement in order to develop the Karakuri System. The dimension and space has been followed based on the technical specification that has been calculate during the design process.

4.2.1 Prototype

To developed a prototype of Karakuri System, a real study based on condition has been used in the line, it use a device such as inclinometer and thread to get the specific length and the degree of gradient. In addition the function of inclinometer is to measure the gradient of the rack at the initial station point and the last station point, while for the thread as a prototype of roller rack as shown in Figure 4.2.1a. Beside that, the space need to be consider in the Sealer line because it very limited and includes others device such as gun holder, regulator and others shown in the Figure 4.2.1b below.

Figure 4.2.1a: Inclinometer

Figure 4.2.1b: Space in the sealer production line

4.2.2 Pilot Test

Before the Karakuri system implement in production line, it tested during a public holiday without any interruption with normal working day. It take a two days to developed the Karakuri rack with favor by the others two helpers. The pilot test is occur for testing a transfer of the door stopper in order to compare the cycle time and prove it be more better as manually before. Figure 4.2.2 shows the implementation of Karakuri rack.

Figure 4.2.2: process implementing of Karakuri concept

4.3 Karakuri System SWCT

The waste of motion is unnecessary physical movement by walking of an operator, which increase the cycle time during the process.Besides, the waste of motion also unnecessary motion and difficult physical movements, due to poorly designed in term of ergonomics, which it slow down the worker performance.After the Karakuri concept has been implemented in the sealer production line, the analysis waste of motion has been conducted to analyze the motion

of an opeartor. The expected result by a Karakuri concept is to reduced in waste of motion as well as to increase company productivity. The waste of motion is analyzed by using Standard work combination table which is as a tool in analyzing the motion of operator movement during the process in the sealer production line
as shown in Figure 12.

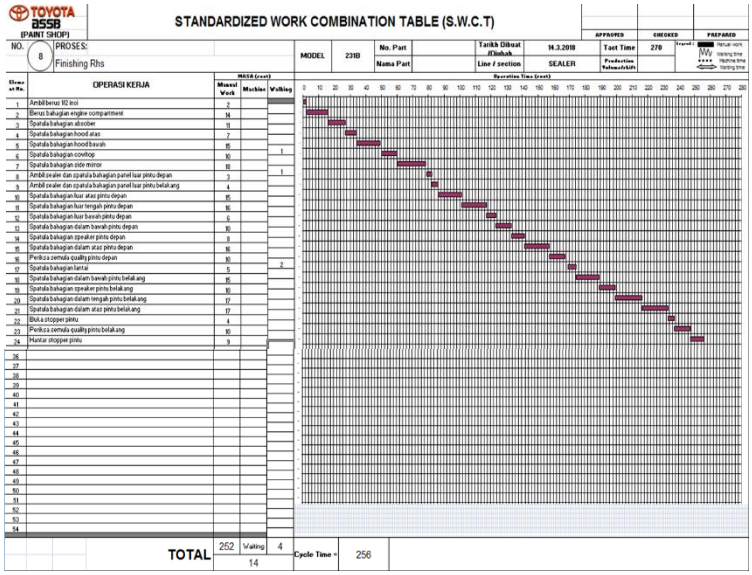

Figure 3: SWCT after implementing Karakuri concept

5.0 ANALYSIS

5.1 Introduction

The analysis of Karakuri concept will be explained in production sealer line and it is important element to make this project successful. Moreover, this analysis shows the actual outcomes in terms of waste reduction, employee ergonomics, employee safety, employee efficiency and company profit. This analysis is divided into two branches which in terms of the effectiveness of roller rack and also in terms of the reduction waste of the motion.

5.2 Analysis on Effectiveness of Roller Rack

The effectiveness of the roller rack is analysed in terms of design that has been calculate and decide based on appropriate gradients. The gradient tested by considers in terms of acceleration, time, and force. This allows the door stopper fixture to be delivered in good condition and faster. In addtion, the roller rack is designed in order to avoid the three elements, MUDA (waste), MURA (load) and MURI (unbalanced) which can cause this roller rack not good and not efficient Figure 5.2 shows the designs that have been developed based on Karakuri's concept by elimination of the three MUDA, MURA and MURI elements, this design has been focus on the MURA (load) when the operator use this Karakuri system it will not have or get any burden to send the door stopper fixture. The operators while send the stopper fixture will not need to step up and also the operator who receives the door stopper fixture no need to bend down to pick up the item. Therefore the concept of roller rack is consider an ergonomic of operator itself.

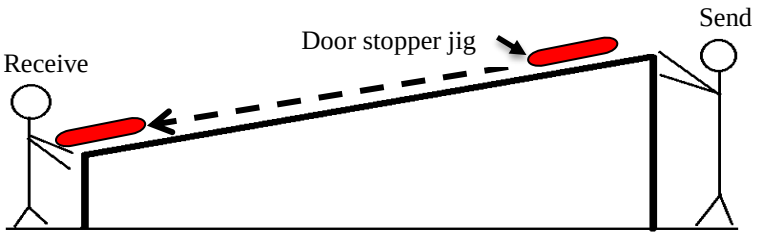

Figure 5.2: Karakuri concepts that eliminate MUDA, MURA, and MURI.

5.3 Properties of the Roller Rack

The characteristics of the Karakuri concept are compatible with the sealer production line which has narrow space at the beside of production sealer line and at the dense space. The length of the roller rack is 8 meters long and the length of the whole station's process is 12 meters long.Figure 5.3a shows the layout and the length of Karakuri system.

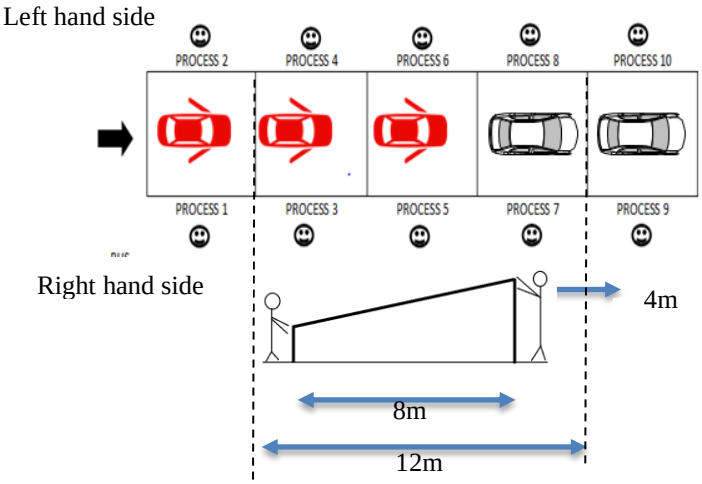

Figure 5.3a: Length of roller rack and of station in the sealer production line

For the next step, the process to set up the roller rack is done by identify the suitability height of the roller rack tops from the delivery process (H1) and the roller rack height of the receipt process (H2), it also involves the gradient (°) that allows the door stopper fixture to slide smoothly. The setting up the height of roller rack is indentify by method of calculation by considering the velocity of the flow and tested at this step. Figure 5.3b shows the height and gradient of roller rack for analysis. An analysis to find the gradients is done twice to allow the door stopper fixtures to be delivered smoothly and steadily.

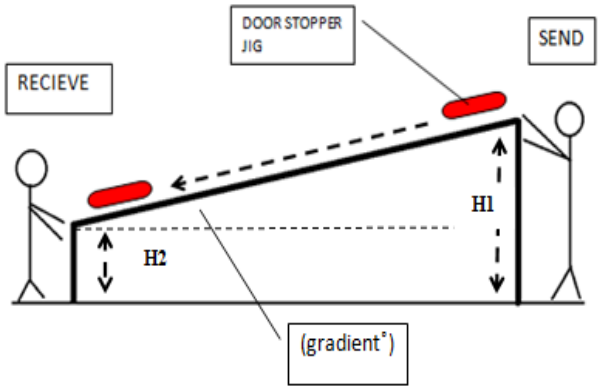

Figure 5.3b: Height and gradient of roller rack

To prove in term of a theoretical calculation , a testing has been done to find the gradient at the first trial, it show that the roller rack which height (H1) at 1.3 meters and the roller rack height (H2) at the receiver is 0.40 meters and the gradient obtained is 5.05˚. The results show that the door stopper fixture was stuck in the middle of the roller rack. Therefore, there is no calculation needed because the roller rack not achieves requirement to be applied in the sealer production line .

To improve the movement of the fixture, the analysis for gradient is made for the second trial of roller rack with height (H1) is 1.8 meters while the height of the roller rack (H2) is 0.5 meters and the gradient obtained is 12.25˚. The

analysis was successful because of the door stopper fixture was moving smoothly towards the receiver. Table 5.3 shows the summary of the two analyzes that have been made.

Table 5.3: Summary of Roller Rack Trial

Trial	**Height**		**Gradient**	**Finding**	
	H1(m)	**H1(m)**	**(°)**		
1	1.3	0.4	5.05	Stuck flow	
2	1.8	0.5	12.25	Smooth flow	/

5.4 Analysis Reduction of Waste Motion

The analysis of reduction waste motion that is considered in terms of work efficiency which includes operator movements, operator safety during work and also ergonomic operator movements has been done. The aim of the analysis is to compare the expected result before and after the Karakuri concept is applied in the sealer production line . The data taken for this analysis is conducted during the normal working day and implemented in detail for the purpose of knowing the actual work of the operator while in work process. The data is required such as tact time, cycle time, working time and also walking time for an operator. All these data were collected and used as a Standard Work Chart (SWCT) as a tool for analysis.

5.5 Standard Work Combination Table (SWCT)

Standard work combination table (SWCT) is the table used to determine the combination of manual operator work and machine work. The limit of a process that can be performed by a worker and a sequence of operations based on tact time. By using this table, the workflow of workers and machines are easy to checked and known in more detail in term of working time. Furthermore, it can also illustrate the workload balance for each operator and tool to determine the important point of training for new employees. Therefore the analysis of the whole process can be determine in order to figure the process either balance by cycle time.

5.6 Analysis Standard Work Combination Table (SWCT) Comparison

The analysis using (SWCT) only focus at the fourth station in the sealer production line , the job scope of the operator in this line is do the finishing process by applying a sealer on the edge car door body or called spatula process.

Figure 5.6: Finishing process or spatula process

Figure 5.6 shows the operator do their job of which is a spatula process. The function of this finishing process is to ensure the sealer was tidy to cover all hole from water leak, and prevent leaking. This workstation is very important and need to more focus, possibility to reduce a waste is highly recommended. Unfortunately, the operator on this

station need to send the door stopper fixture to the first workstation and it can cause waste of motion and also disturbing the process if the operator send it manually by walking. The analysis is about to compare the SWCT before and after implement the Karakuri concept as a material handling to reduce the waste of motion operator.

5.6.1 SWCT before Implements Karakuri Concepts

The analysis using the SWCT is used to determine the several work processes completed by the operator in the fourth station. There are 24 steps of spatula process for one body car. The tact time on the sealer production line is 270 seconds and the operator should have done the spatula process before the tact time is over. Unfortunately, the takt time for this process have exceed the actual tact time with 327 seconds. This will result in unbalanced line to the process and the operator will pull the Andon or stop the line because of their process is still uncompleted. The process is interrupted because the movement of operator when to deliver the door stopper fixture to the second station that required the operator to walking for 40seconds to the station. It will raise many safety issues if the operator walking fast or running to deliver the door stopper fixture in the line. Furthermore, this movement will produce the MUDA (waste) that will affect the process in the sealer production line . The waste of motion in the fourth station will produce high cost because of the line is stop. Moreover, if the operator is not able to complete the finishing process, there are higher chances of the body car to produce defect such as producing sealer hole that will cause the body to have water leak.

5.6.2 SWCT after Implements Karakuri Concepts

The analysis of SWCT after implementation of Karakuri concept give high impact to the sealer production line , this is because of the huge changes in the cycle time of the operator that reduces from 327 to 256 seconds is needed to complete the whole process. The tact time of the sealer production line is always the same which is 270 seconds. By implementing the Karakuri concept, the operator in the fourth station can complete their work before the tact time is reached and this will not be distracting other process. Furthermore, the operator will no longer need to deliver the door stopper fixture to the second station. Moreover, MUDA (waste) which burdened the operator to do the spatula process can be reduce in terms of waste of motion. With the implementation of the material handling which using the Karakuri concept, the operator can only take 9 seconds to deliver the door stopper fixture compared to before that takes longer time of 40 seconds. The operator also will no longer need to walk to the second station because of this Karakuri concept is functional by using the gravitational method and with the suitable gradient can able to deliver the door stopper fixture smoothly to the other receiver. Therefore, the operator safety issues can be protected as there will be no movement from one station to other station to deliver the door stopper fixture and the defects can be reduced. It does not only reduce the defect, otherwise there is a high chance in producing the body car without any defect as the operator will have time to complete their own process.

6.0 RESULTS

From the analysis of comparison before and after implementation of the Karakuri concept by using the SCWT, waste of motion is able to be reduced in terms of movement of the operator in the fourth station. Furthermore, the issue regarding the line stops because of the uncompleted work and the defect also can be reduce. With the implementation of the Karakuri concept, the operator can only take 9 seconds to deliver the door stopper fixture compared to before which took longer time of 40 seconds by walking.

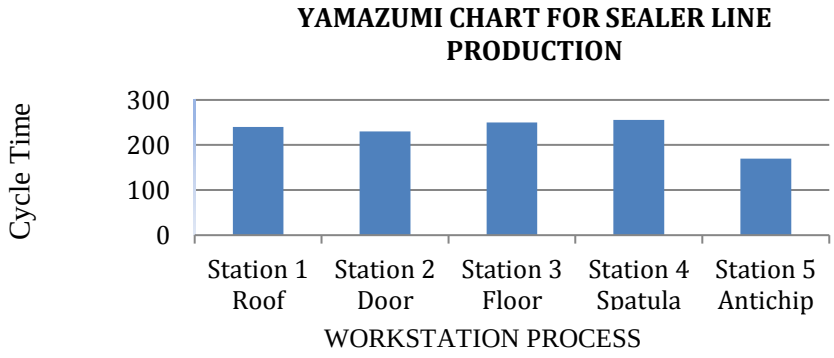

Figure 6.0 : Sealer production line Yamazumi chart

Figure 6.0 is the Yamazumi chart which shows the stability of the operator in completing the process inside the sealer production line . The Yamazumi graph shows the perfect cycle time followed by every operator in the workstation process. The perfect cycle time is achieved because of the operator of every workstation did not exceed the tact time and every process in the workstation is in the stable condition.

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KAJIAN TERHADAP KAEDAH PENYEMBURAN BAHAN KIMIA DENGAN MENGGUNAKAN PANEL SOLAR DAN MUNCUNG SEMBURAN RACUN BOLEH LARAS DALAM SEKTOR PERTANIAN

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ABSTRAK

Pam penyembur bahan kimia ialah alat yang digunapakai dengan menggunakan muncung sembur untuk kegunaan menyembur seperti racun rumpai, racun perosak dan pembajaan daun kepada tanaman pertanian sayur-sayuran. Alat ini digunakan untuk menyembur serangga perosak dan serangan penyakit pada tanaman sayur-sayuran. Tujuan kajian ini untuk menghasilkan satu kaedah penyembur bahan kimia jenis teknologi knapsack sprayer yang menggunakan panel solar dengan mengecas bateri dan muncung yang boleh dilaraskan. Kajian ini adalah untuk mengatasi masalah masa yang lama diambil iaitu dalam lingkungan 8-10 jam untuk mengecas bateri dan muncung semburan yang sediada di pasaran tidak boleh dilaraskan menyukarkan pengguna untuk menyembur racun pada tanaman pada jarak yang agak jauh atau tinggi. Objektif kajian ini adalah untuk mengenalpasti kadar ketahanan bateri alat penyembur racun ketika penyemburan racun dijalankan dengan menggunakan tenaga solar. Seterusnya mengenalpasti kadar jarak semburan dengan menggunakan muncung yang boleh dilaraskan sehingga mencapai jarak 3m hingga 4m. Kaedah ini berkonsepkan rendah karbon kerana ia menggunakan panel solar bagi mendapatkan tenaga suria untuk ditukarkan kepada tenaga elektrik. Penggunaan kawalan solar digunakan untuk mengawal arus yang keluar masuk dan mengawal arus berlebihan sekiranya bateri dicas. Bahagian muncung alat ini menggunakan aplikasi berkonsepkan tekanan sistem hidraulik iaitu dimana muncung boleh dilaraskan mengikut kesesuaian ketinggian tumbuhan. Dengan kerjasama dari pihak RISDA Seksyen 9 Shah Alam, kaedah ini telah di uji di sekitar kawasan kebun komuniti kecil seluas 2.5 hektar di Seksyen 20 Shah Alam, Selangor. Hasil dapatan daripada 20 responden sekitar tersebut, menyatakan bahawa ketahanan bateri iaitu sebayak 4 jam dengan penggunaan secara berterusan dan jarak penyemburan sejauh 3 meter. Secara kesimpulan kajian ini berpotensi untuk dijadikan salah satu kaedah penyembur racun jenis teknologi knapsack sprayer yang menggunakan solar panel bersama dengan alat kawalan muncung yang boleh dilaraskan mengikut kesesuaian ketinggian tanaman untuk memudahkan aktiviti meracun bagi para pertani.

KATA KUNCI : *Penyembur racun, solar panel, muncung yang boleh dilaras*

1. PENGENALAN

Tidak boleh dinafikan, penggunaan bahan kimia dalam membasmikan rumpai dan serangga amat popular digunakan oleh petani dalam penjagaan tanaman. 80% daripada masalah utama yang dihadapi oleh petani adalah serangan penyakit dan serangga perosak tanaman. Terdapat pelbagai jenis serangga perosak dan penyakit pada tanaman sayur-sayuran yang menyebabkan kerugian yang amat besar kepada petani. Serangga perosak seperti Ulat beluncas, siput babi, belalang, kumbang, kutu daun dan siput babi menyerang di bahagian daun, putik buah dan batang pada tanaman sayur-sayuran sehingga hasil pengeluaran menjadi kurang dan kos menggunakan racun meningkat. Bagi mengatasi masalah ini teknologi kaedah knapsack sprayer telah digunakan secara meluas dikalangan pekebun-pekebun kecil dalam mempertingkatkan produktiviti mutu pertanian.

Dikebanyakkan negara-negara membangun di Asia, teknologi knapsack sprayer adalah yang paling popular dan paling ekonomik. Menurut Mohd Johaary (2011) petani di Malaysia mengamalkan penggunaan knapsack sprayer dengan menggunakan pestisid untuk tanaman seperti padi, tembakau dan sayur-sayuran. Namun begitu, teknologi knapsack sprayer memerlukan bahan pembakaran dan elektrik untuk mengecas bateri. Aplikasi ini akan terhad dimana kos bahan api yang mahal dan jika berlaku gangguan bekalan elektrik yang boleh mengganggu aktiviti penyemburan pada tanamana mereka. Buat masa kini permintaan terhadap bahan pembakar amat tinggi dan ia merupakan cabaran yang amat besar bagi negara membangun seperti di Malaysia. Ini menyebabkan kos pengunaan knapsack sprayer menjadi semakin tinggi yang disebabkan oleh penggunaan bahan pembakaran tersebut. Dengan adanya pemasalahan ini maka wujudnya alat penyembur bahan kimia dengan menggunakan teknik pembangunan moden iaitu mengunakan solar panel sebagai alternatif bagi meneruskan aktiviti penyemburan bahan kimia pada tanaman sayur-sayuran. Alat ini juga mempunyai muncung sembur yang boleh dilaraskan untuk kegunaan menyembur seperti racun rumpai, racun perosak dan pembajaan racun

kepada tanaman pertanian. Teknologi knapsack sprayer mempunyai pelbagai bentuk daripada buatan manusia mudah alih (selalunya beg sandang dengan alat penyembur) sehinggalah semburan auto seperti traktor dengan kadar semburan 60-151 kaki jauhnya. .Ianya merupakan salah satu alatan pertanian yang digunakan secara meluas dalam sektor pertanian. Ia selalu digunakan oleh para petani dan pekebun sama ada di kawasan yang kecil mahupun kawasan yang luas untuk memudahkan lagi aktiviti pertanian. (Anim Agro Teknologi, 2010).

2. SOROTAN KAJIAN

2.1 Kaedah Penyemburan bahan kimia Menggunakan Knapsack Sprayer.
Kaedah penyemburan bahan kimia yang digunakan oleh golongan petani di Malaysia adalah dengan menggunakan pam penyembur bahan kimia knapsack sprayer. Pam penyembur ini merupakan alat yang digunakan untuk menyembur larutan dari dalam tong tangki kepada sasaran (biasanya rumpai, daun, batang, tanah dan sebagainya). Melalui muncung yang bertekanan tinggi. Knapsack sprayer terdiri daripada jenis manual dan jenis bermotor. Pam jenis manual adalah alat yang menggunakan tenaga manusia untuk mengepam menggunakan tangan. Kebiasaanya golongan petani kecil menggunakan pam air manual sebagai pilihan memandangkan kos yang murah, mudah diselenggaraan, ringan, kecekapan yang tinggi serta mudah dikendalikan tanpa memerlukan kepakaran dalam bidang tersebut. Manakala pam jenis bermotor adalah alat yang dipasang dengan pengepam yang mampu mengepam secara mekanikal. Pam jenis bermotor pula, digunakan bagi kawasan semburan yang luas, lebih cepat dan dapat menyembur tempat yang tinggi serta dapat menjimatkan kos penggunaan buruh.

Komponen knapsack Spayer manual terdiri daripada tong simpanan, pam, sesalur, nozel dan tali pengendong. Tong simpanan larutan diperbuar daripada plastik yang mempunyai pelbagai saiz isipadu. Saiz yang biasa dijual dipasaran adalah tong yang bersaiz 4 gelen (18 liter) kerana berat tong berkenaan adalah dalam lingkungan 20 kg apabila diisi larutan dan berat ini sesuai untuk dipikul oleh pengguna. Komponen pam terdiri daripada sistem pam injap mudah gerakan keatas dan ke bawah bagi menghasilkan tekanan udara ke dalam tong simpanan. Pemegang muncung yang digerakkan dengan tangan akan menghasilkan tekanan di dalam tong dan cecair larutan akan keluar melalui sesalur dan muncung.

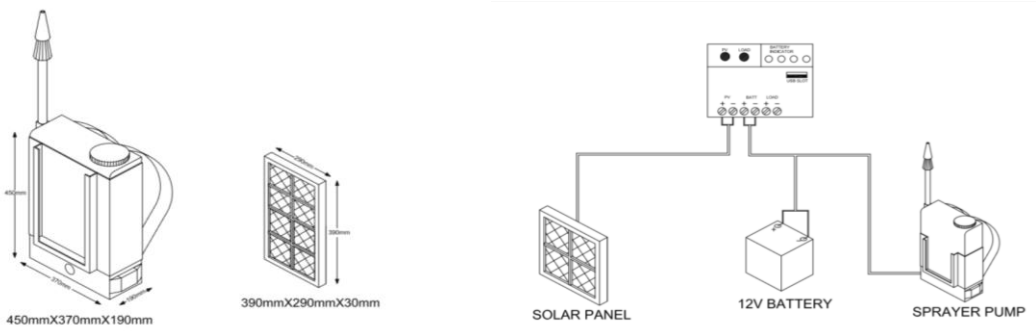
2.2 Kaedah penyemburan bahan kimia menggunakan teknologi knapsack sprayer jenis panel solar dan muncung boleh laras.
Arus pemodenan yang pesat telah menukar kaedah konvensional kepada kaedah baharu.. Kaedah baharu ini lebih kearah mesra alam kerana menggunakan panel solar untuk mengecas ketahanan bateri pada alat penyembur bahan kimia. Proses penyemburan bahan kimia ini merupakan salah satu inovasi teknologi yang dihasilkan dalam sektor pertanian. Kaedah penyemburan ini diketengahkan bagi mengatasi masalah kos yang tinggi terhadap pembelian bahan pembakaran. Selain itu, masa mengecas tenaga bateri pada penyembur bahan kimia adalah lebih singkat dan muncung boleh laras bagi menukar muncung yang statik di pasaran pada masa kini. Kaedah penyemburan bahan kimia, ia juga boleh dilakukan secara automatik. Ia adalah sebuah sistem penyemburan bahan kimia yang telah dibangunkan bagi tujuan penyemburan bahan kimia secara cepat, tepat dan berkesan. Penggunaan sistem penyemburan ini dapat menjimatkan kos bahan pembakaran dan mengurangkan tenaga pekerja selain ianya dapat mengurangkan tenaga elektrik. Kelebihan penggunaan tenaga solar ini dapat mengurangkan pencemaran dan bunyi bising (Shubham, 2018). Bahan utama yang digunakan bagi membangunkan peralatan teknologi knapsack sprayer ini adalah modul SPV, pengawal caj, bateri secara terus dengan aliran elektrik, bingkai, tangki penyembur, paip hos, muncung boleh laras, pam dan sebagainya. Panel Solar jenis SPV digunakan iaitu dengan menggunakan tenaga solar untuk mengecas bateri bagi menggantikan penggunaan bahan pembakaran.

3. METODOLOGI KAJIAN

Objektif utama kajian ini adalah bagi menghasilkan alatan yang digunakan bagi menyembur bahan kimia dalam penjimatan ketahanan masa mengecas bateri lebih singkat dan kadar kecekapan muncung boleh menyembur dengan jarak sejauh 3m. Kajian ini dijalankan di kawasan kebun komuniti kecil seluas 2.5 hektar di Seksyen 20 Shah Alam, Selangor. Masalah utama yang dihadapi oleh petani dikawasan kebun komuniti di Seksyen 20 adalah mereka memerlukan masa yang lama diambil untuk mengcas iaitu dalam lingkungan 8-6 jam namun penggunaan untuk mengepam pula agak singkat iaitu dalam lingkungan 3-4 jam sahaja. Di samping itu, petani menghadapi masalah muncung pam racun tidak boleh dilaras menyebabkan jarak pancutan air pada saluran keluar racun hanya pada jarak yang dekat dan menyukarkan petani untuk menyembur racun pada had tanaman yang tinggi.

Berdasarkan kepada kajian dan tinjauan yang dijalankan terhadap alat penyembur bahan kimia sedia ada, penyelidik telah membuat penambahbaikan dari segi ketahanan bateri pengepaman dan mekanisma

penyemburan muncung boleh laras. Inovasi telah dilaksanakan terhadap penggunaan solar jenis polikristal. Pemilihan jenis ini adalah kerana jenis ini dapat menghasilkan kuasa pada saat kurang percahayaan. Kecekapan perubahan daya dan daya ketahanan alat ini dapat memberi kelebihan pada alat ini. Jenis panel solar ini amat sesuai digunakan untuk kegunaan setiap hari. Manakala muncung boleh laras telah dikaji spesifikasinya bagi meningkatkan kecekapan dan keseragaman taburan air racun dan baja ke seluruh tanaman sebagaimana yang dikehendaki oleh petani.



Rajah 1: Lakaran dan Litar Diagram Komponen Alat Penyembur Bahan Kimia

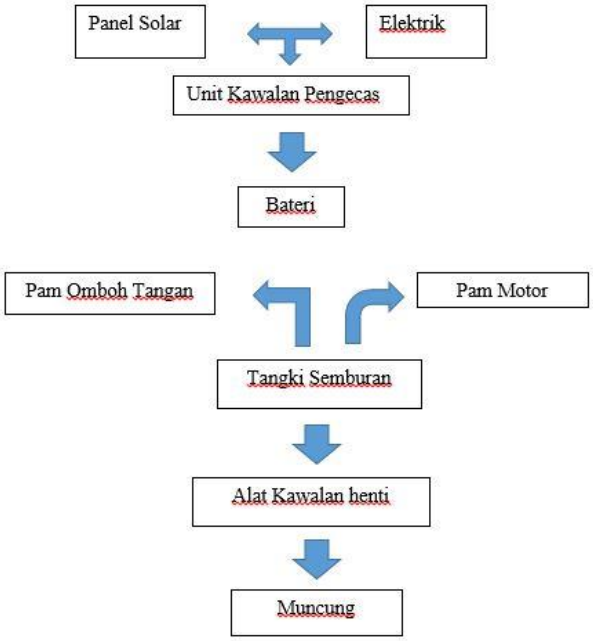
Rajah 2: Langkah Proses Pemasangan Alat Penyembur Bahan Kimia

4. DAPATAN KAJIAN

Berdasarkan pada Carta Alir **Rajah 3** diatas, satu langkah telah dijalankan bagi melaksanakan kajian ini :

i. Voltan DC (arus langsung) dijana oleh panel solar, mengikut keperluan panel solar kuasa telah dipilih. Ketiadaan bateri tenaga solar boleh dikenakan oleh tenaga elektrik.

ii. Unit kawalan caj disediakan antara bateri dan panel solar menghalang terbalik aliran bateri ke arah paneldan mengelakkan daripada pengecasan bateri berlebihan.



Rajah 3 : Carta Alir Proses Panel Solar & Muncung Sembur Boleh Laras

iii. Voltan DC dijana dalam bateri digunakan untuk menjalankan pam motor DC yang dihubungkan antara tangki semburan dan alat kawalan henti.
iv. Tuas yang dikendalikan tangan disediakan untuk beroperasi penyembur jika tiada solar dan tenaga elektrik.
v. Pam keluar (Outlet Pump) dan peranti henti disambungkan oleh paip hos untuk membekalkan cecair semburan untuk semburan di bahagian muncung. Peranti henti digunakan untuk memotong bekalan cecair semburan dan menghalang pembaziran cecair.

Bagi menjayakan kajian ini satu produk iaitu `*Solar Weed Sprayer'* seperti pada Rajah 4.

Rajah 4 : Penyembur Bahan Kimia Solar Panel dan Muncung Boleh Laras

Panel solar digunakan untuk menukarkan cahaya matahari ke dalam elektrik (DC). Proses penukaran pertama memerlukan bahan yang menyerap tenaga suria dan kemudian menimbulkan elektron kepada tenaga yang lebih tinggi dimana aliran elektron tenaga tinggi ini terus kepada litar luaran. Bahan silikon kristal kebanyakkan digunakan untuk proses ini. Apabila panel solar dihasilkan, sel-sel elektron bersambung bersama . Hasil Voltan bergantung kepada kecekapan sel dan saiz dan kawasan sel dalam panel. Setelah proses pengujian, perbandingan yang dapat dibuat di antara penggunaan alatan penyemburan racun baja sedia ada dengan `*Solar Weed Sprayer'* seperti Jadual 1.

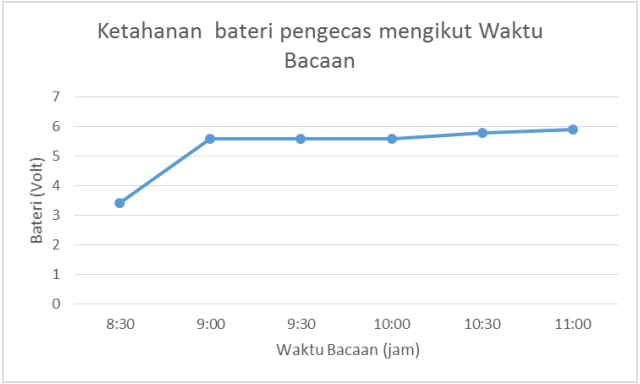
Jadual 1: Perbandingan di antara Kaedah Konvensional dengan Kaedah Baharu

Keterangan	Kaedah Konvensional	Kaedah Baharu
Masa mengecasan bateri Solar Panel (Jam)	Masa yang lama diperlukan untuk mengecas bateri iaitu dalam lingkungan 8-10 jam bagi proses ketahanan mengecas bateri bagi keluasan batas tanaman 6000m^2	Masa yang diperlukan lebih singkat bagi mengecas bateri iaitu dalam lingkungan 4 jam bagi setiap keluasan batas tanaman 6000m^2
Lebar (m)	300	300
Kadar ketahanan bateri (Jam)	Kadar ketahanan bateri produk sediada mengambil masa 3 jam ketika penyemburan racun dan baja	Kadar ketahanan bateri mengambil kira 4-5 jam ketika penyemburan racun dan baja
Kadar jarak semburan racun dan baja	Kadar jarak semburan racun dan baja pada produk sediada di pasaran adalah agak pendek iaitu 1 meter	Kadar jarak semburan racun dan baja pada produk adalah lebih jauh iaitu 3 meter
Pengepam Air	Memerlukan tenaga manusia yang banyak	Tidak menggunakan tenaga manusia yang banyak

Bateri pengecasan Panel Solar bersama penyembur bahan kimia jenis teknologi knapsack Sprayer telah dikaji untuk menentukan tempoh operasi penyemburan. Bateri telah dikenakan oleh Panel Solar yang telah sepenuhnya terdedah pada cahaya matahari dan pada masa yang sama bateri telah digunakan untuk mengendalikan penyembur Panel Solar. Pelbagai parameter seperti voltan bateri, bateri semasa, voltan panel, arus panel, telah diukur.

Jadual 2: Data Waktu Bacaan bagi Pengecasan Ketahanan Bateri Panel Solar Penyembur Bahan Kimia

No	Waktu Bacaan (Jam)	Suhu ºC	Bateri (V)	Kelajuan Angin (m/s)
1	8:30	30	3.4	0.2
2	9:00	31.5	5.6	0.2
3	9:30	32.8	5.6	0.7
4	10:00	34.7	5.6	0.4
5	10:30	36.1	5.8	0.4
6	11:00	38.2	5.9	0.6



Rajah 1 : Ketahanan Bateri Pengecas SPV Berdasarkan Waktu Bacaan (Jam)

5. PERBINCANGAN

Dari kajian dan pemasangan produk *`Solar Weed Sprayer'*, pengkaji mendapati

i. Penggunaan alat penyemburan bahan kimia amat sesuai digunakan untuk alat tenaga alternatif penjimatan tenaga elektrik bagi ketahanan bateri dalam penyemburan di kawasan tanaman.
ii. Masa mengecas bateri lebih singkat dan ketahanan bateri yang lebih lama dapat meyakinkan kepada pekebun kecil untuk menggunakan teknologi knapsack sprayer ini
iii. Muncung yang boleh dilaras ini dapat menentukan jarak penyemburan yang lebih jauh mengikut ketinggian tumbuhan dan tanaman.
iv. Komuniti pekebun kecil boleh menerima teknologi yang terbukti untuk dilaksanakan oleh mereka.

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PENGIKTIRAFAN

`Solar Weed Sprayer' telah mendapat pengikhtirafan " Golden Award " di Final Projek Civil Engineering (FPCE) pada sesi Jun 2018. Ini melayakkan kajian ini dipertandingkan di "INVENTION & INNOVATION TECHNOLOGY EXPOSITION" pada sesisi yang sama di peringkat Politeknik Sultan Salahuddin Abdul Aziz Shah, Shah Alam.

A SHORT REVIEW ON NATURAL FIBER REINFORCED POLYVINYL CHLORIDE AND ITS APPLICATION

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ABSTRACT

The properties of polymer composites using materials from renewable sources such as natural fiber produced high specific strength, low weight, and low cost, relatively good mechanical properties, non-coarse, environmentally friendly and bio-degradable attracted many researchers and academic to study on it. The aim of this short review article is to describe on natural fiber reinforced Polyvinyl Chloride and its application. It presents types of natural fiber and its properties, natural fibers that used with Polyvinyl chloride and its application.

KATA KUNCI: *Natural fiber, Polyvinyl Chloride*

1. INTRODUCTION

The demand for natural fiber is increasing due to the progressive contamination of the environment of using synthetic fibers and a shortage of petroleum resources (Liu et al. 2015). The study on natural fibers as reinforcement in matrix increase tremendously due to replace the appliances that are made from chemicals. While the existing research will continue to be improved in mechanical properties. Building industries compete in developing new materials with lightweight and extreme tensile strength to apply this material in aerospace industries, building industries like mining, tunnel and automotive industries(Hebel et al. 2014). Natural fiber composites are very cost effective material especially in building and construction, packaging, automobile and railway coach interiors, and storage devices (Verma et al. 2013). Natural fibers are eco-friendly; lightweight, strong, renewable, cheap and biodegradable (Joshi et al. 2004; Mittal 2016).

The composites science offer significant opportunities for improved materials from renewable resources with enhanced support for global sustainability. Natural fiber composites are attractive to industry because of their low density and ecological advantages over conventional composites. These composites are potential candidates for replacement of high cost glass fiber for low load bearing applications (Verma et al. 2013). Due to the advantages of natural fibers such as renewable, low cost, sustainable, high specific strength and low density, the natural fiber reinforced polymer composites are preferable (Wang and Ying 2014). Compared to glass fiber, the natural fibers gives no skin irritation and much less abrasion of machine parts in the compounding process (Kohler et al. 2003). However, the main disadvantages of natural fiber composite are the relative high moisture absorption. Therefore, chemical treatments are done so as to modify the fiber surface properties.

2. CLASSIFICATION OF NATURAL FIBERS

Natural fibers can be classified according to animal fibers, mineral fibers and plant fibers (Student 2014). Nowadays most of the natural fibers used for polymers are plant fibers where the plant fibers can be classified to seven categories that namely bast, leaf, seed, fruit, wood, stalk, and grass fibers. Table 1 shows types of plant fibers and fiber groups.

Table 1: Types of Plant and Fiber Groups (Jawaid and Abdul Khalil 2011; Nirmal, Hashim, and Megat Ahmad 2015)

Wood fiber	Stalk fiber	Grass fiber	Fruit fiber	Seed fiber	Leaf fiber	Bast fiber
Hardwood	Bamboo		Coconut	Cotton	Sisal	Rattan
Softwood	Wheat		Betelnut	Oil Palm	Manila	Hemp
				Seed		
Sawdust	Rice			Kapok	Banana	Jute
	Grass			Alfafa	Palm	Ramic
	Barley				Mengkuang	Banana
	Corn				Date Palm	Flax
					Pineapple	Sugarcane
					Abaca	Kenaf
						Roselle

3. PROPERTIES OF NATURAL FIBERS

The composition of single fiber cement affects the physical and mechanical properties of a composite (Student 2014). The chemical composition of natural fibers is seen on the percentage of cellulose, hemicelluloses, lignin, pectin, waxes, and water content. The physical and mechanical properties of the composites also depend on the age and method of processing the natural fibers. Table 2 shows that kenaf has the highest cellulose with a value 72wt % compared with other natural fibers. The ASEAN Post said that in Malaysia, kenaf is fast becoming the country's third industrial crop after palm oil and rubber after first being introduced in 2010. Bamboo has the lowest composition of cellulose with value 26-43 wt%, however the benefit of using bamboo has short maturation period where about 3-5 years and it is one of the most abundant forest resources in Malaysia (Bahari and Krause 2015).

Table 2: Chemical Composition of Some Common Natural Fibers (Faruk et al. 2012; Verma et al. 2013)

Fiber	Cellulose (wt %)	Hemicellulose (wt%)	Lignin (wt%)	Waxes (wt%)
Bagasse	55.2	16.8	25.3	-
Bamboo	26-43	30	21-31	-
Banana	64	6-19	5	
Flax	71	18.6-20.6	2.2	1.5
Kenaf	72	20.3	9	-
Jute	61-71	14-20	12-13	0.5
Hemp	68	15	10	0.8
Ramie	68.6-76.2	13-16	0.6-0.7	0.3
Abaca	56-63	20-25	7-9	3
Sisal	65	12	9.9	2
Coir	32-43	0.15-0.25	40-45	-
Oil palm	65	-	29	-
Pineapple	81	-	12.7	-
Curaua	73.6	9.9	7.5	-
Wheat straw	38-45	15-31	12-20	-
Rice Husk	35-45	19-25	20	-
Rice straw	41-57	33	8-19	8-38

The density and tensile properties are tabulated in Table 3 while Table 4 shows the production of natural fibers in the world. From the table, we can see that most of the density of the natural fibers is between 1.2 to 1.5 g/cm^3. Bamboo shows the highest Young's modulus with value of 35 GPa compared with other natural fibers. From table 4 shows that the highest world production of naturals fibers is sugar cane bagasse with value of 75 000x10^3 ton and followed by bamboo with value of 30 000x10^3 ton.

Table 3: Mechanical properties of natural fibers materials (Biagiotti, Puglia, and Kenny 2004; Retnam, Sivapragash, and Pradeep 2014)

Fiber	Density (g/cm^3)	Diameter (µm)	Elongation at break (%)	Tensile strength (MPa)	Young's modulus (GPa)
Flax	1.4-1.5	40-620	2.7-3.2	343-1035	27-80
Jute	1.3-1.5	30-140	1.4-3.1	187-773	3-55
Abaca	1.5	17-21	10-12	980	72
Sisal	1.3-1.5	100-300	2.0-2.9	507-855	9.0-28.0
Kenaf	1.22-1.4	40-90	3.7-6.9	295-930	22-53
Bamboo	1.4	10-330	1.4	440	35

Table 4: Natural fibers in the world and their world production (Faruk et al. 2012)

Fiber source	World production (10^3 ton)
Bamboo	30 000
Sugar cane bagasse	75 000
Jute	2300
Kenaf	970
Flax	830
Grass	700
Sisal	375
Hemp	214
Coir	100
Ramie	100
Abaca	70

4. SIZE, ORIENTATION, DISPERSION AND CONTENT OF FIBER

Fiber size plays an important role in determining the characteristic of the material instead of types of polymer. Factors like constituents, concentration, geometry and orientation of the reinforcement and volume fraction determine the properties of the composite to a greater extent (Abilash and Sivapragash 2013). The most factors that influenced the properties of short fiber composites are fiber length , fiber dispersion, fiber orientation and fiber-matrix adhesion (Rowell et al. 1997). Bamboo fibers (precisely fiber bundles) are often brittle compared to other natural fibers because of their thicker diameter and high content of lignin and hemicelluloses which will affect the fiber bundle integration, individual fiber strength and fiber bundle strength (Phong et al. 2011). Table 5 shows the comparison natural fiber size and achievement of the composites.

Table 5: Comparison of natural fiber size and achievement

Type of fiber and matrix	Fiber Size	Achievement	Ref.
rice hull/PVC	45 µm, 75 µm, 106 µm, 180 µm and 250 µm	• The larger particle sizes resulted higher impact strength • The particles average sizes 106 µm and beyond are embedded in the matrix. • The best tensile modulus occurred at 60% of particles content.	(Petchwattana and Covavisaruch 2013)

husk of water bamboo/epoxy	0.175 mm & 0.3698mm	• The char yield of epoxy increased 13.5-52.8% at 10% fiber content.	(Shih 2007)
sugarcane bagasse/LDPE	1.0mm	• The young modulus increased 72% and flexural modulus increased 85% from neat LDPE at 25% content of cellulose fibers.	(Moubarik, Grimi, and Boussetta 2013)
Kenaf/PP & jute/PP	Long and discontinuous natural fiber (kenaf and jute)	• Kenaf/PP composites have the highest tensile and flexural modulus at 30% contents of fiber. • Jute/PP composites have the highest tensile and flexural modulus at 40% contents of fiber.	(Lee, Kim, and Yu 2009)
Kenaf/PU	between 125 and 300 µm	The best tensile strength at 30% fiber contents.	(El-Shekeil et al. 2012)

Commonly short fiber is used in applications that require moderate loads, moderate stiffness and high volume production (Shaharuddin 2006). The fiber length of kenaf fiber and jute fiber may need to be shortened to make more fibers incorporate into the bio-composites but too short fibers may affect the processibility of the carding operation (Lee, Kim, and Yu 2009). All composite parts that have common characteristic are the effect of fiber orientation on the final properties of the composite (Shaharuddin 2006). When s stress is applied in the direction of fiber orientation the elastic modulus is higher compared when it is applied transverse to it (Shaharuddin 2006). One of the factors that can influence the properties of natural fiber composites is the hydrophilic nature of fiber and fiber content (Ku et al. 2011).

5. SURFACE MODIFICATION BY AN ALKALI-TREATMENT AND SILANE COUPLING AGENT

Natural fibers have hydrophilic surface while polymers matrix have hydrophobic surface and this will make them incompatible and has a tendency to form aggregates (Ku et al. 2011). The natural fiber surface has waxes and non-cellulosic substances such as lignin, hemicellulose and pectin that will effect the physical and mechanical properties due to the poor adhesion between matrix and fibers (Fuentes et al. 2013; Xie et al. 2010) Therefore to improve fibers hydrophobic surface, adhesion of matrix-fiber, roughness and wettability, and decrease moisture absorption the chemical modification was used. By increasing fibers hydrophobicity will increase the tensile properties. There are variety of surface modifications such as chemical treatments and coupling agents.

6. NATURAL FIBERS REINFORCED POLYVINYL CHLORIDE

PVC is one of the most common thermoplastic that has been used in our world and can be found many applications in building and construction, for example, for window and door frames, siding, pipes, electric wires, window profiles and other exterior (Ge, Li, and Meng 2004; Khalil et al. 2012) PVC was introduced as a contaminant material due to releasing harmful substances to the atmosphere such as hydrogen chloride and dioxins during processing or decomposition. The combination of PVC and natural fibers is an interesting alternative due to the 'ecological friendliness' of natural fiber. Table 6 shows the applications of rigid and flexible PVC.

Table 6: Applications of Rigid and Flexible PVC (Khalil et al. 2012)

Application	Rigid PVC	Flexible PVC
Construction	Window frame, gutters, pipes, cars, house, siding, ports, roofing	Water proof membranes, cable insulation, roof lining, green houses
Domestic	Curtain rails, drawer sides, laminates, audio and video tape cases, records	Flooring, wall coverings, shower curtains, leather cloth, hosepipes
Packaging	Bottles, blister packs, transparent packs and punnets	Cling film

Transport	Car seat backs	Under seal, roof linings, leather cloth upholstery, wiring insulation, window seals, decorative trim
Medical	-	Oxygen tents, bags and tubing for blood transfusion, drips and dialysis liquids
Clothing	Safety equipment	Waterproofs for fisherman and emergency services, life jackets, shoes, Wellington boots, aprons and baby pants
Others	Credit cards	Conveyor belts, inflatables, sports

From table 6 we can see that PVC whether rigid PVC or flexible PVC were used a lot in our daily used such as in construction, domestic, packaging, transport, medical, clothing and others. However the effect of using a lot of PVC can harm the atmosphere due of high chlorine content. This chlorine creates toxic pollution in the form of dioxin and accumulate in animals' fat up through the food chain. The exposure to PVC often includes exposure to phthalates, which may have serious health effects. Previous research that have been done with PVC composites such as wood/PVC (Bai et al. 2011; Deka and Maji 2011; Shah, Matuana, and Heiden 2005; Sombatsompop and Chaochanchaikul 2004; Tungjitpornkull and Sombatsompop 2009; Xu et al. 2014), Moso bamboo/PVC (Qian et al. 2015; H. Wang et al. 2010, almond husk (Fazal and Fancey 2008), sugarcane bagasse/PVC (Saini et al. 2009), rice straw/PVC (Kamel 2004) and etc. Most of the results showed that the tensile strength and modulus elasticity increased by using treated fibers compared to untreated fibers.

7. CONCLUSION

The search for new materials by the industry is increasingly driven by the production of lighter, stronger, renewable materials and lower cost. The worldwide use of PVC can be detrimental to the environment, so replacement of PVC is essential to address this problem. Polymer composites reinforced with natural fibers are one way to solve this problem. However, the selection of natural fiber types, appropriate treatment, fiber size, fiber orientation, and fiber content plays an important role in producing optimum properties. It can be seen that some types of natural fibers such as bamboo, pineapple, and sugar cane are among the alternative natural fibers with short maturity, abundant resources in Malaysia and good mechanical properties.

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A STUDY ON IMPROVING THERMAL EFFICIENCY IN CONVEYOR OVEN THROUGH PRE-HEAT PROCESS

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ABSTRACT

This study beginning in approaching of improvement of oven pre-heat process as the currently running on lack of performance as the upper heater inside oven fails to function and only running at lower heater only. This show the lack of power need to be improved through the heat process to achieve better temperature and the best cycle time. The concept of idea is to shut down the one door and only use one door operation only in reducing heat loss. In step of improving the oven, process is brainstorm on how to create a new process with one door operation. The solution obtains from the method of tray in bakery oven industry where the operation at high temperature without failure. In real situation of tray system is more proper with roller attachment while the conveyor is dissembled from oven, but for this experiment is to prove the method of one door operation with tray process simulate the suppose proper tray as the experiment conduct the tray process on conveyor frame. The experiment on analysis the pre-heat process where the process of tray system is being monitored same with oven temperature panel indicate the temperature inside the oven. The experiment on conveyor system is monitored to see the temperature dropping in 1 cycle process and comparing the temperature drop in tray system to see the improvement of heating process of tray and method of one door operation. The experiment in this process will change the all process sequence element also contribute to improving the method including in reducing cycle time and possible cost down on electric consumption.

KEYWORDS: *oven, tray, conveyor, preheating*

1. INTRODUCTION

In the automotive business, ABC Engineering Sdn Bhd developed and produced product supplies for customers demanding parts of automotive such as headlining, carpet floor, trunk lid, backdoor, and anything related to carpet manufacturing. Since the core that benefits the ABC is leading the carpet manufacturing industry in Malaysia, CIM, this mass production in making the carpets for automotive part product as mentioned before, is continued during both day shift and night shift.

Although there are many products produced by ABC Engineering Sdn Bhd , the journey in the developing process in order to create a product is not an easy task to be completed. It took a lot of time, effort and thinking in order to cover up the task. The common element in the creation process begins with designing, but as a vendor, the part design is usually done by the customers. There are many procedures in designing but the main procedure is the process design to create a successful process operation. Most of the parts manufactured by ABC Engineering Sdn Bhd focus on car interior which starts with the needle punch process, where the raw materials like pet black fibre are processed to produce carpet in a roll, later on being cut using a cutting machine to form various sizes of carpet slab. Then, it enters the process which forms the shape of parts by applying heat and press processes. Other different types of interior parts also apply the same processes as it requires the same process principles namely the heating process, forming process with different setups, parameters, designs and necessary process methods. With all the processes in making a product, the methods used during the process can determine the product quality. This is crucial as the customers demand satisfactory hence, the company must provide the required specification. The process details required for quality can be provided by customers or it can be suggested by the company based on company capability in manufacturing.

This research has been carried out at ABC Engineering Sdn Bhd which examines how to increase productivity in manufacturing automotive OEM part. Additionally, this research topic is selected based on the potential in making improvement in the production lines in ABC Engineering Sdn. Bhd. The part produced in the

selected production line is the trunk trim-side for national car model. The production line also produces deck trim side for Perodua Myvi. The car model name codes are D63D and D20N. In producing interior parts for trunk of car for both models from carpet material require the heating process which is the main process in making the part as it requires the soft properties of a carpet for the forming process to be successful by pressing the mould to shape the carpet into the required part. The research focuses on the pre-heat process as it is the starting process informing shape parts. The heating process uses the conveyor oven by feeding the oven with a carpet slab and exit at the other side of oven as it passes through the heater inside the oven to heat up the carpet.

2. LITERATURE REVIEW

2.1 Needle Punch Process

A fabric web or batt of fibre is the source of nonwoven fabric from a needle punch in a way of driving the barbed needle the fibre upward and downward. The various orientations of fibre are bonded by friction force reaction of needling action point.

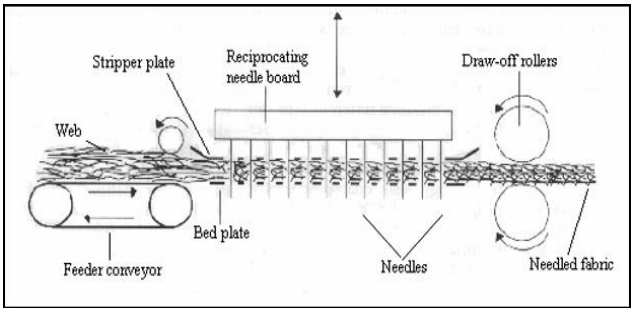


Figure 1: Needle punch process (Art, 2015)

Figure 1 shows the principle of the Needle Punching Process. The needle board is the base unit into which the needles are inserted and held. The needle board then fits into the needle beam that holds the needle board into place. The feed rolls and exit roll are typically driven rolls and they facilitate the web motion as it passes through the needle loom. The web passes through two plates, a bedplate on the bottom and a stripper plate on the top. Corresponding holes are located in each plate and it is through these holes, the needles pass in and out. The bed plate is the surface the fabric passes over which the web passes through the loom. The needles carry bundles of fibre through the bedplate holes. The stripper plate does what the name implies; it strips the fibres from the needle so the material can advance through the needle loom (Gowri).

2.2 Material

The material produced for the deck trim side for D63D is the carpet slab consisting of PET black and NV layer which contain recycled fibre that has gone through a needle pinching process to bond both layers without any resin or latex of form of chemical. Both fibres of the material bones are bonded under friction force reaction. The PET black layer density in the slab is 300g/m^2, and NV layer density is 600g/m^2. The slab is formed with a dimension of 1600mm × 1100mm through the cutting process after carpet roll is produced by needle punch, with slab density becomes 900g/m^2.

2.3 Forming process

Each automobile interior material is hot-pressed moulded at 170° C into a predetermined moulded shape to obtain an automobile three-dimensionally moulded interior material. After each automobile interior material has been hot-press moulded under the condition of 170° C, and 5 kg/cm, when the temperature is lowered to 80° C, the interior material is removed from the moulding die. Thus, an automobile three-dimensionally moulded interior material (1600 mm longx1100 mm wide) is obtained. Next, after the automobile three-dimensionally moulded interior material is put in the next station for the finishing process (Evans,2006).

2.4 Pre heat process

During the preheating process, the oven uses 12 quartz lamps for both top and bottom mount heaters. The temperature required for the heating process in heating up the carpet slab is 200℃ which is considered a low temperature for the process (En.wikipedia.org., 2019).

The processes begin with the carpet slab being received from the cutting process then being put on top of the steel net conveyor and the conveyor operation is controlled using a button in the control panel. By pushing the button, it activates the electric motor that drives the connector then drives the conveyor with the slab on top of it into the oven. The operation of the conveyor stops as the net frame touches the sensor which breaks the electric circuit to open the circuit in order to stop the electric motor from allowing the conveyor to keep moving. As the slab enters inside the oven chamber, the feeding door is closed in the reaction of the conveyor sensor touching the stop sensor. The same sensor is integrated by controlling both operations in stopping the conveyor and closing the door. The door operation is controlled by pneumatic system which is the air pressure as the medium in transferring the force. The pneumatic system uses an actuator in moving up and down to open and close the door. The same operation applies to the front door. Inside the oven chamber, the preheating process starts as the door closes while the heating element continues, where the power heating continuously supplies heat from the beginning until the end of the daily production. The time required for the heating process depends on oven setting parameter, in this case, of deck trim part. It takes about 90 seconds to complete the process. The carpet slab stops being heated as the front door opens in reaction to the timer in the control panel and the conveyor moves a little bit forward for the safety of workers to unload the carpet slab. The process procedure is continuously repeated for mass production (Journal, 2017).

3. RESEARCH METHODOLOGY

3.1 Process of Conveyor

In this study the conveyor preheat process is shown in Figure 2. The process starts by taking out the slab for forming and back at the point of taking the slab at the back. In total, 7 steps were repeated each time for every 1 cycle.

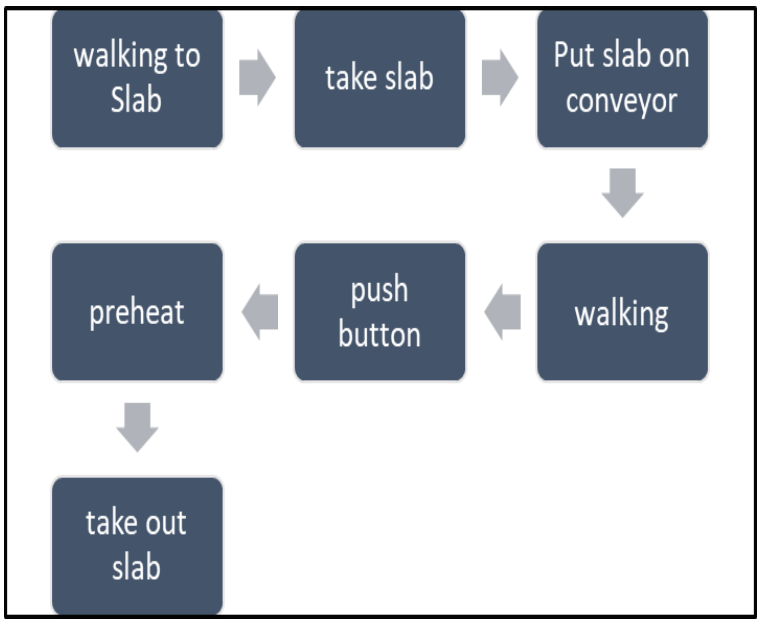


Figure 2 : Process flow chart

Figure 3 illustrates the process layout where all the work elements track down in a movement point to point starting from number 1 by taking the slab where worker walks to the slab, no 2 is putting the slab on the conveyor, no 3 is where the worker walks to the electric panel to push the start button to preheat process and while waiting, the workers usually prepare the slab and places it near the conveyor and standby at the exit of the oven door.

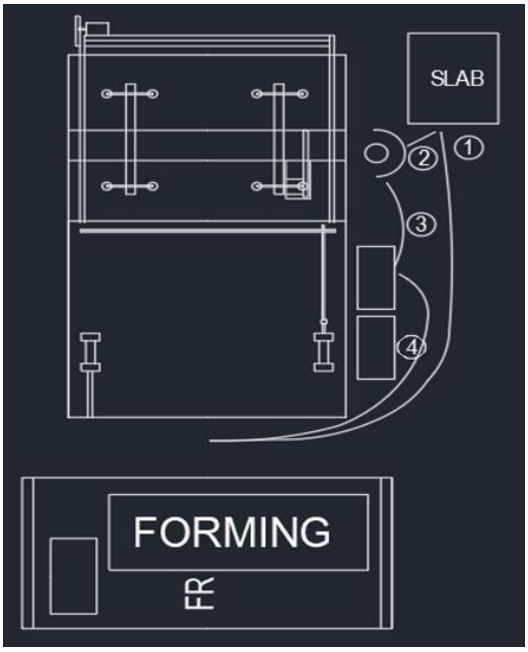


Figure 3 : Pre heat process layout

3.1.1 Conveyor Process Cycle Time

Oven preheat process in the current activity is based on the process of workers synchronised with the oven process system which includes the conveyor system and oven door operation by recognizing the flow step in the current process to be analysed. Table 1 below showed the process cycle time.

Table 1: Conveyor process cycle time

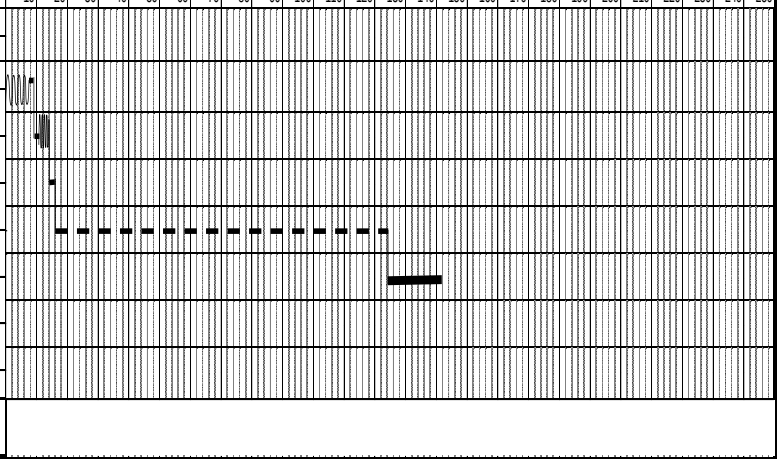
LINE	WSA D63D Deck Trim Side	TIME MEASUREMENT CHECK SHEET							MEASUREMENT DATE		
PROCESS	Pre-heat								MEASUREMENT TIME		
PART	D63D								MEASURER NAME		
NO	Work sequence	1	2	3	4	5	6	7	8	9	10
	oven pre-heat										
1	walking to Slab	7.71	7.10	8.23	8.01	7.19	7.57	7.98	7.21	8.14	7.89
2	take slab	1.30	1.50	1.75	2.10	1.46	1.39	1.34	1.51	1.48	1.32
3	Put slab on conveyor	1.34	1.62	1.57	1.40	1.60	1.35	1.42	1.36	1.54	1.39
4	walking	4.09	3.78	3.21	3.81	4.00	3.54	3.81	4.15	4.00	4.11
5	push botton	1.68	1.71	1.55	2.01	2.40	2.00	1.70	1.79	1.68	1.57
6	preheat	110.00	110.00	110.00	110.00	110.00	110.00	110.00	110.00	110.00	110.00
7	take out slab	18.53	18.62	18.97	19.01	19.27	18.83	17.57	18.35	17.79	18.43
8											
ONE CYCLE TIME		**144.65**	**144.33**	**145.28**	**146.34**	**145.92**	**144.68**	**143.82**	**144.37**	**144.63**	**144.71**

Table 2 shows the standard work combination of work progress and non-work progress. The work progress of worker is 22.9 second and the combination of machine work progress are 110 second and non-work progress like waiting and walking is 11.1 second.

Table 2: Standard work chart preheat process

PART NO & NAME	D63D	STANDARD WORK COMBINATION TABLE	DATE		REQUEST SHIFT		MANUAL
PROCESS	Pre-heat		SECTION		TAKT-TIME		AUTO / WALK

NO	OPERATION	TIME MANUAL	TIME AUTO	TIME WALK
	oven pre-heat			
1	take slab	1.3		7.7
2	put slab into conveyor	1.4		3.4
3	push button	1.7		
4	oven pre-heat (Auto)		110.0	
5	take out slab from oven	18.5		
6				
7				
TOTAL		22.9	Wait	11.1



3.2 Designing of Tray

A designing tray was developed by using CATIA V5 R25. In which was done after the sketching phase is decided. Additionally, the tray design was considered the oven dimension, internal measurement. Furthermore, steel was selected as tray material, in which high capability to withstand the heat from the oven during the preheating process. In Figure 4 indicates the details of tray design drawing. Table 3 shows the tray dimensions are based on the available oven space inside by referring to the internal oven dimension and also the conveyor net dimension. This is to ease the operation in tray process system. The information below shows the dimension change before the trial experiment where the tray will be fit inside the oven for fitting test and exposed to heat up to 180℃.

Table 3: Changes of dimension upon testing tray to heat reaction

Dimension	Conveyor	Tray	Frame
Before L×W(mm)	1500×1600	1580×1560	1600×1580
After L×W(mm)	1500×1600	1510(+handle) ×1540	1520×1555
Weight(kg)	-	3.8	16.5

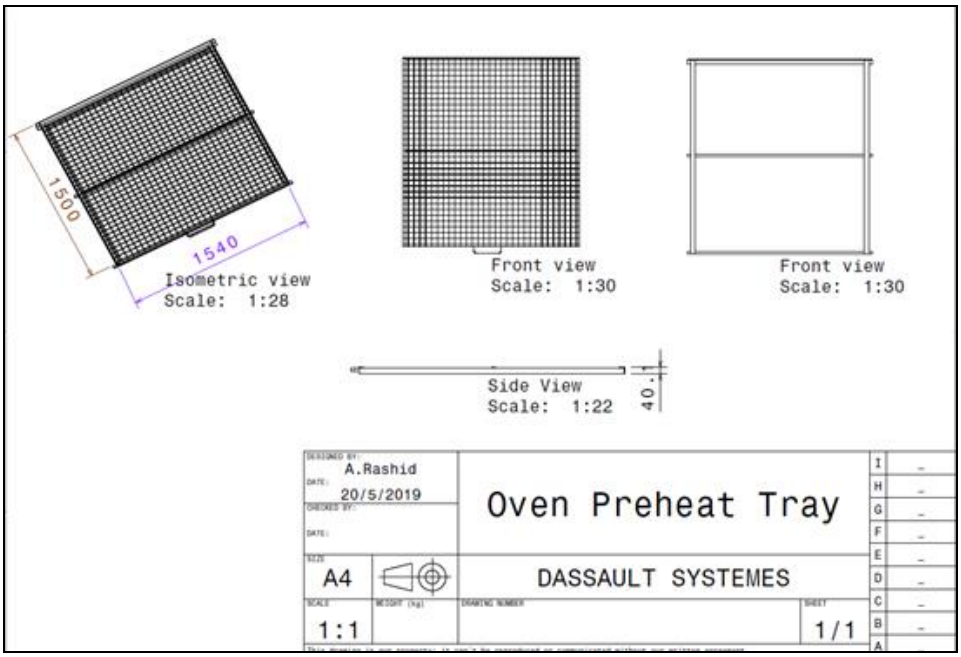


Figure 4: Drawing of tray design

3.3 Layout Design Consideration

The layout design is the current layout of the oven process in deck trim side production line. The current layout of the carpet slab is far from the rear oven door, while the new layout will be redesigned for the carpet slab to be closer to the oven door. Figure 5 shows the current position of carpet slab incoming in production line.

Figure 5: Current position of carpet slab in the line production

3.4 Oven Temperature in Conveyor Process

Table 4 : Temperature data trial for conveyor process

Cycle	Max Temperature	Min Temperature	Temperature Drop
1	162.1	153.9	8.2
2	160.4	157.0	3.4
3	167.0	163.3	3.7
4	170.7	162.2	8.5
5	164.0	158.6	5.4
6	164.0	159.2	4.8
7	161.9	151.0	5.9
8	162.2	155.7	6.5
9	163.8	160.4	3.4
10	168.0	162.5	5.5
11	171.2	163.3	7.9
12	165.1	158.9	6.2
13	163.7	159.0	4.7
14	162.5	158.7	3.8
15	164.7	158.7	6.0
16	168.3	160.2	8.1
17	173.5	167.6	5.9
18	169.4	164.9	4.5
19	167.3	161.7	5.6
20	166.2	160.1	6.1
	3316	3196.9	114.1
Average	165.8	159.8	5.705

Table 4 shows data sheet represents data collected and translated from the activity of observation in the line production. The failure to recognize the data required and inaccurate data collection can lead to failure in producing a valid result, eventually making the study research to not be valid as false data and false result is generated.

3.5 Tray Actual Simulation Analysis

The tray is referring to the device using to support and placing the slab onto the tray surface made by steel frame and steel net for pre-heat process as the device slide in the oven for heating will be analyse based on it weight and movement to find the force need for worker in order to operate in mass production. Using basic physic equation to find force of:

i. Initial force needs to move the tray
ii. Force need to continue to move the tray

4. RESULT AND DISCUSSION

4.1 Data Oven Pre-heat Process Before Improvement

Oven preheat process in the current activity is based on the process of workers synchronised with the oven process system which includes the conveyor system and oven door operation by recognizing the flow step in the current process to be analysed.

The old process on the Table 5 below shows the work sequence data of time and distance travelled in 1 cycle. Based on the data collected on cycle time showed in Table 4.1 above show that the total time taken for 1 cycle is 144.12 seconds, while the distance travelled is 17.6 meter, the distance which the worker moves from one task to another throughout the process.

Table 5: Process cycle time

Work Sequence	Description	Time (s)	Distance (m)
1	Walking to Slab	7.71	6.5
2	Take slab	1.3	0.9
3	Put slab on conveyor	1.34	
4	Walking	4.09	1.7
5	Push button	1.68	
6	Preheat	110	-
7	Take out slab	18.53	6.5
TOTAL		144.12	17.6

4.2 Data Analysis for New Tray

Finite element analysis is where the design will be tested based on actual setting parameter where the time of the preheat process is 90 seconds. The result of analysis includes directional heat flux, and total heat flux. This analysis is to define the critical point or a hotspot on the tray. Based on the Figure 6, the heat acts on a tray at 180 degree in 90 seconds. The maximum value is 3.5982e-11 w/mm2, while the minimum is -9.586e^{-12} w/mm^2.

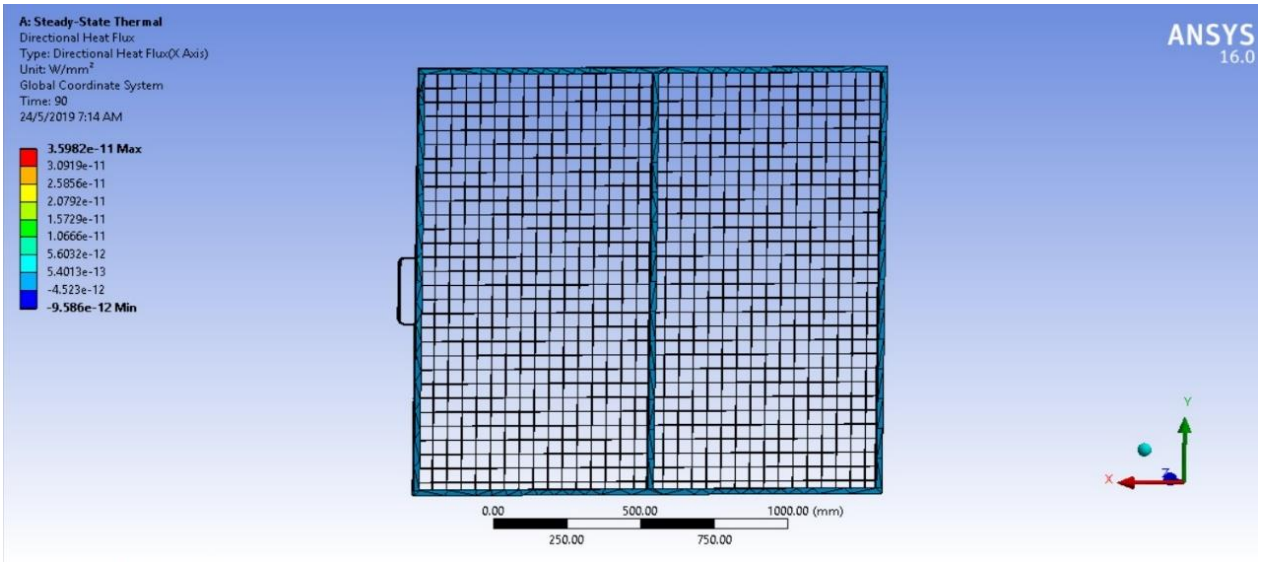


Figure 6: Direction of heat flux

The Figure 7 depicts the total heat flux in the duration of 90 seconds with heat of 180 degree celcius. Both Figures show that the heat flux is at its maximum at the time of 90 seconds. The result shows the condition of tray at maximum heat.

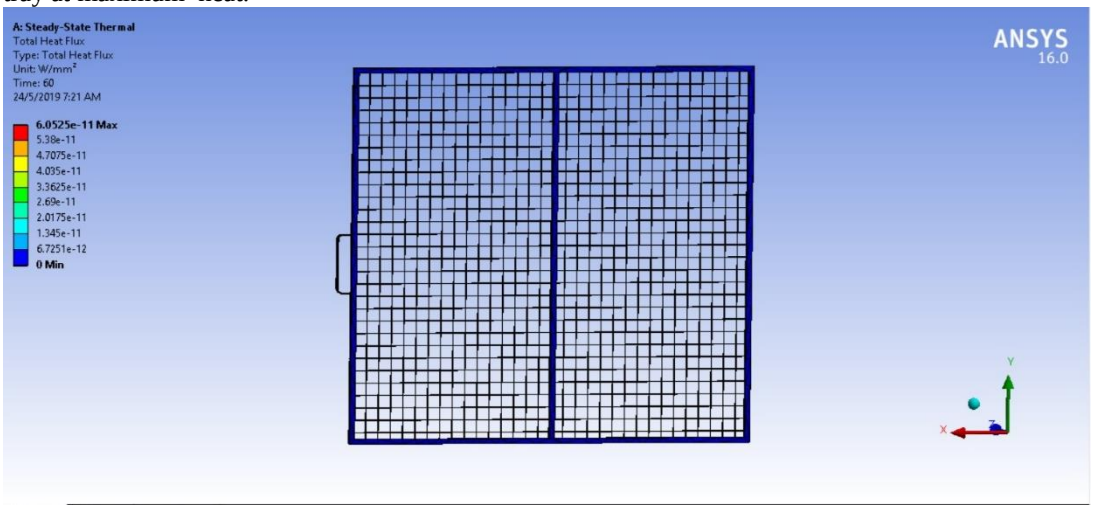


Figure 7: Steady state thermal

At this phase the design needs to be analysed to see what will happen in the actual situation in 90 second. Based on Figure 8 shows the contour of expansion of heat reaction. The analysis is the steady heat thermal which is the value of heat temperature that acts on the tray

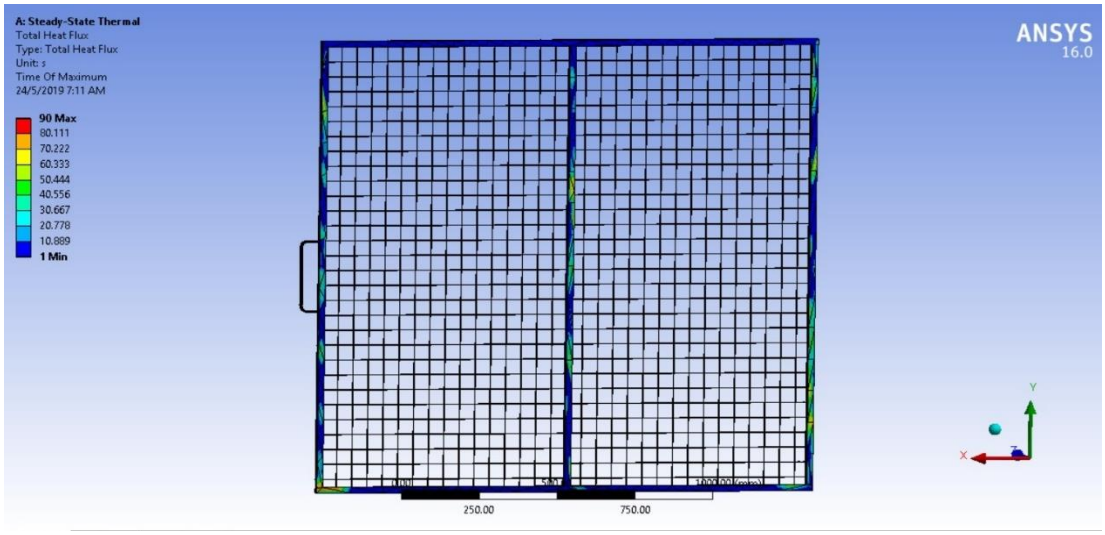


Figure 8: Total heat flux

The result Figure 9 shows the frame changes in from the heat which is 180 degree Celsius. A minor change in shape and figure below depicts the heat flux at 180 degree, but the change does not affect the operation of tray movement

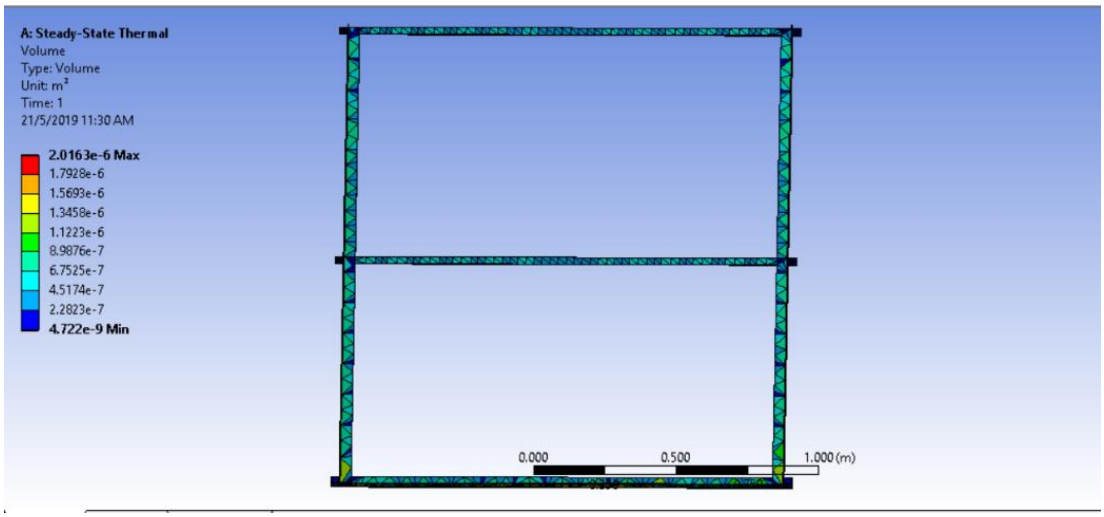


Figure 9: Volume in heat

Figure 10 shows the heat flux of tray frame with 180℃ of temperature act on frame. The result showed the frame in colour contour in green colour area indicate highest heat absorb as the area of lower frame is far from oven door which show the heat loss near door is highest than the heat loss inside the oven.

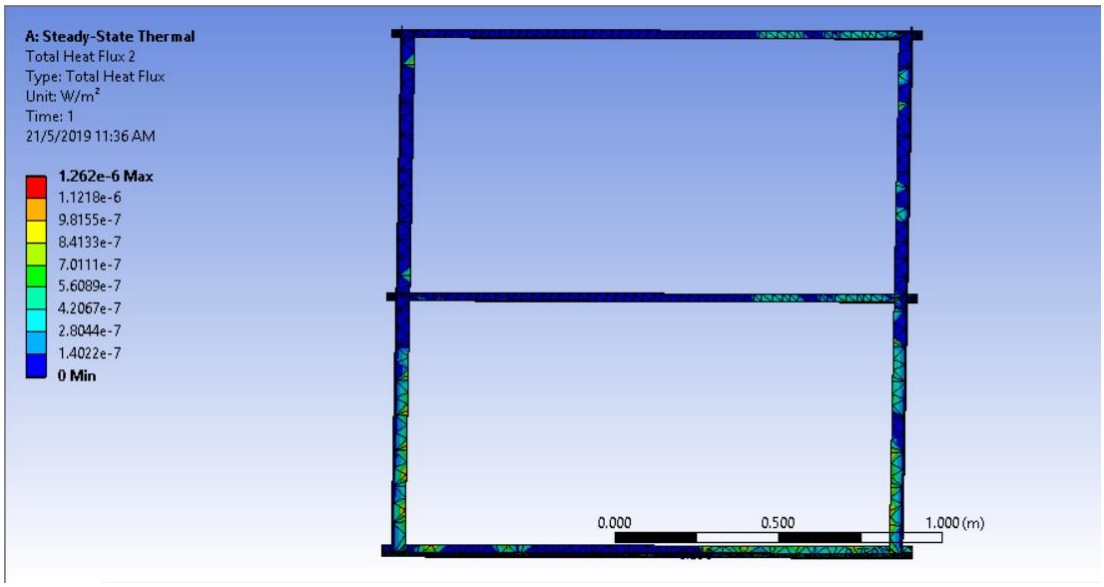


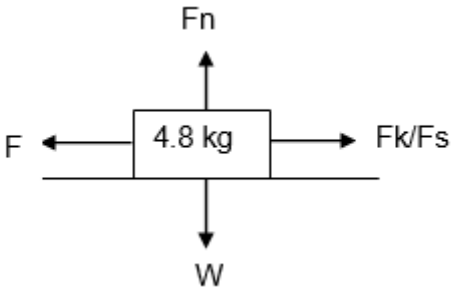
Figure 10: Heat flux

4.3 Tray Fabrication for Movement Analysis

In testing the oven tray and frame, it is placed inside the oven that has been heated up to 180℃ where time has been excluded to see if the tray movement process can continue for production. Before testing the design, the design has gone through the heat simulation on Ansys software where it shows the changes in volume on maximum value of $2.0163e^{-6}$ m^2 with the average increase in volume is $8.9876e^{-7}$ m^2.

During the actual attempt of first trying to test the tray, the tray got a little bit stuck due to the expansion of both parts when exposed to heat. The second dimension is where the tray and frame dimension has been reduced to avoid the stuck issue while undergoing the preheat process and has been tested for the second attempt where the issue has been overcome. Also, the weight should also be considered as it could affect the whole process, where a heavy tray will affect the health of the workers. To convince that weight is an issue, the force to pull the tray is calculated. The illustration and calculation is show below:

i. Coefficient static friction, Fs = 0.6 - 0.15 (0.375)
ii. Coefficient kinetic friction, Fk = 0.09 - 0.6 (0.345) (Chen, 2004).



- based on the calculation of F, static is:

$$F = Fs$$
$$F = \mu s\, F$$
$$F = \mu s\, mg$$
$$F = (0.375)(4.8)(9.81)$$
$$F = 17.66\ N$$

Based on the calculation above, it is shown that the initial force required to pull the tray is >17.66 N The force required for the tray to continue to slide is shown below:

- based on the calculation of F, kinetic is:

$$\sum Fx = F - F\text{k}$$
$$max = F - \mu\text{k (mg)}$$

- to get F, acceleration is needed where the distance and time are provided based on the data below:
  d = 1.5 m
  t = 1.5 s

$$a = \frac{\Delta V}{t}$$
$$V = \frac{d}{t}$$
$$V = \frac{1.5}{1.5}$$
$$V = 1\ m/s$$
$$a = 1\ m/s_2$$

insert an into the equation:

$$(4.8)(1)x = F - (0.345)(4.8)(9.81)$$
$$4.8 = F - 16.25$$
$$F = 4.8 - 16.25$$
$$F = 11.45\ N$$

Based on the calculation above, it is shown that the force required for the tray to continue sliding is 11.45 N This value means that the operation of the tray process will not affect the worker's health as the force can be equated as lifting a weight of 1.1 kg

4.4. Data of Oven Pre-heat Process with Tray After Improvement
Figure 11 shows below the flow chart of the work element sequence that different from work element sequence before improvement

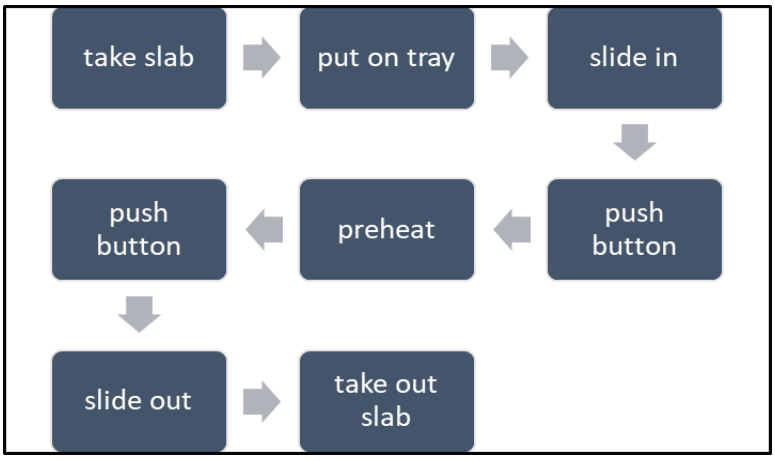


Figure 11: Flow Process of the tray system

4.5 Analysis of Process
Figure 12 shows the graph of cycle time comparison since the new process excludes the conveyor system it causes the work element and its cycle time to be changed due to the changes of the process. The conveyor process cycle time take 144.12 second to complete 1 cycle while tray process cycle time take 116.6 second to complete 1 cycle. This give the different 27.52 second less for tray system which also prove 19.8% more efficient than conveyor process

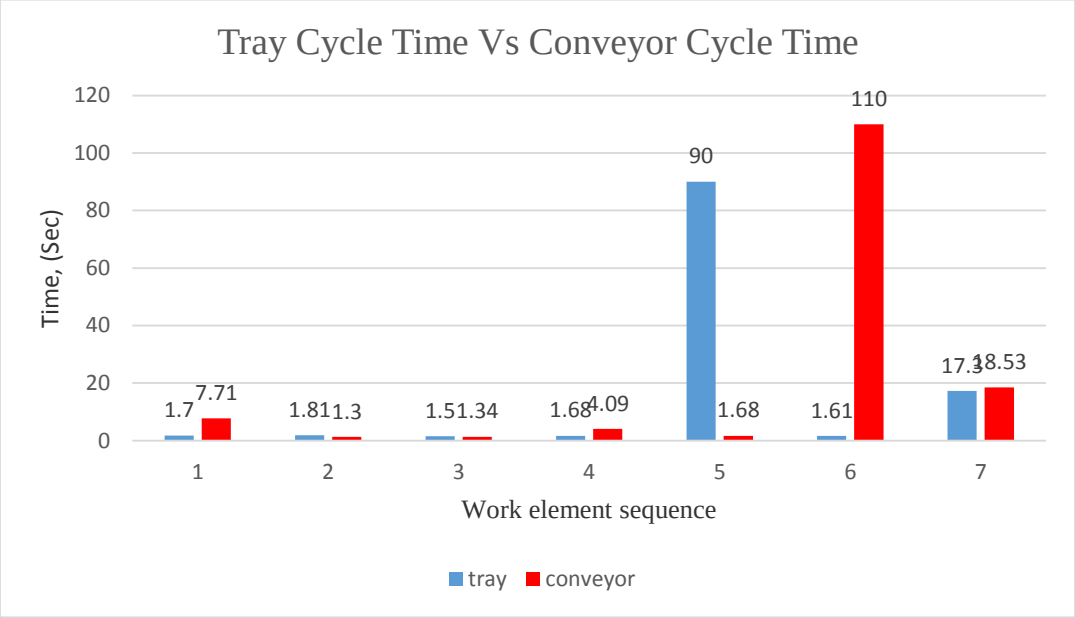


Figure 12: Graph of Cycle Time

Based on Figure 13 shows graph of distance between method of tray and method of conveyor and based on Table 4.10 show the difference in meter with 12.8 different in value. The result show that its percentage of distance travelled by worker which reduced about 72.7%, from 17.6 meter to 4.8 meter

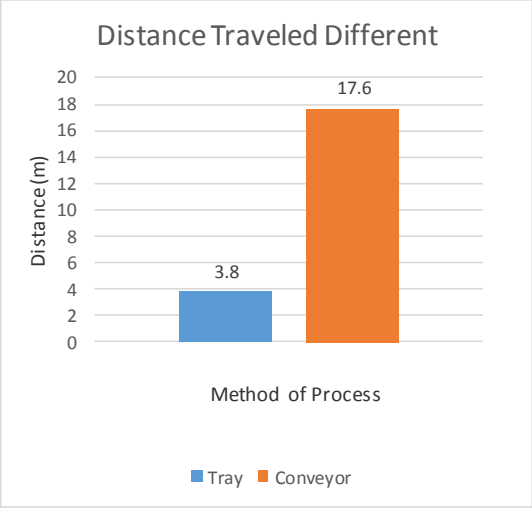


Figure 13: Graph of Distance

4.6 Comparison of Data Analysis for Preheat Temperature

Table 6 shows is the data of the tray process temperature drop collected for 20 cycles of complete process.

Table 6: Data of temperature drop for tray process

Cycle	Max Temperature	Min Temperature	Temperature Drop
1	165.3	161.6	3.7
2	167.4	163.0	4.4
3	167.0	163.	4.0
4	175.7	172.1	3.6
5	175.0	171.2	3.8

6	173.8	169.3	4.5
7	174.1	170.2	3.9
8	172.9	168.5	4.4
9	173.2	169.2	4.0
10	175.8	170.3	5.5
11	176.2	169.9	6.3
12	172.7	167.7	5.0
13	169.8	165.1	4.7
14	172.4	168.6	3.8
15	170.8	166.3	4.5
16	168.8	163.0	5.8
17	167.9	162.9	5.0
18	170.6	166.3	4.3
19	173.0	168.7	4.3
20	174.9	171.3	3.6
	3437.4 171.7	3348.2 167.4	86.7(89.1) 4.335

Based on Figure 14 showed the graph of temperature drop from the conveyor process to tray process which drops in mean temperature of 5.705 value in temperature resulting in 23.31% decrease in temperature. This comparison analyses data before and after improvement.

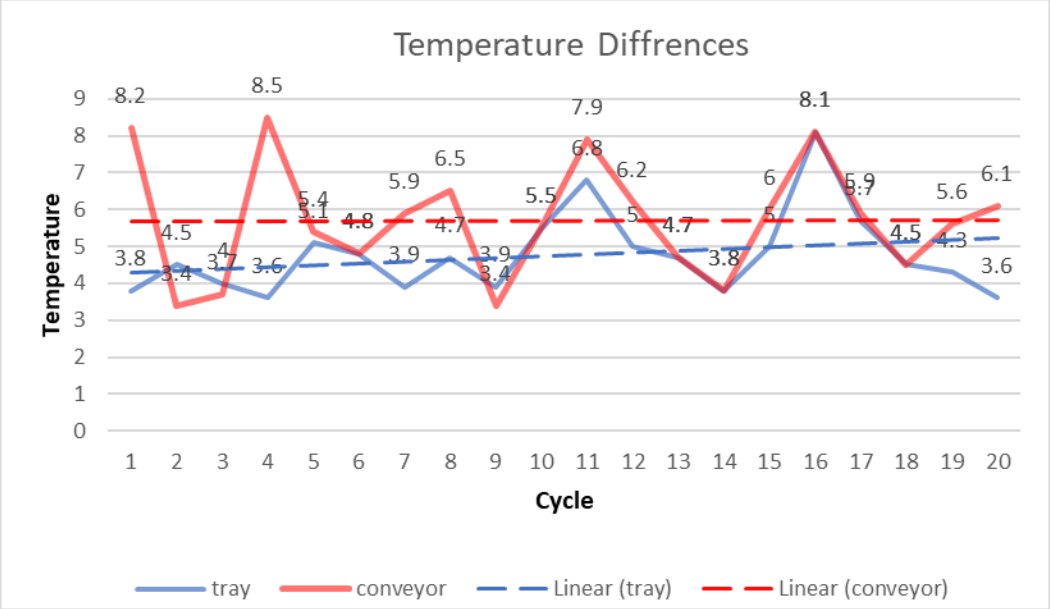


Figure 14: Graph of Temperature Dropt

4.7 Data For Electric Saving Cost

In calculating the electric consumption, the oven spec power is considered, but because the oven is damaged, it could give inaccurate output data as the calculation is based on the heater spec. The tariff value is based on the category of the industry which is D with value of 0.441.

Heater spec: 12 pcs

Watt = 2200

Volt = 240

Based on calculation and Table 7 below show the cost saving in electric consumption of tray is RM 2448.6 per month while conveyor cost RM 3075.6 per month showed up the saving can be achieved in RM 627 per month while RM 7524 per year. This show the cost saving is 20.39% less for tray process compare to conveyor process. Figure 15 show the pie chart of cost saving.

Table 7: Cost Saving In Electric Consumption

Process	Tray	Conveyor
Formula	kW x h x tariff	
	2.2kw x 12 x 0.0319 x 0.441	2.2kw x 12 x 0.04 x 0.441
Cost per part	Rm 0.371	RM 0.466
	300 parts x .0371	300 parts x 0.466
Cost per day	RM 111.3	RM 139.8
Cost per month(22days)	RM 2448.6	RM 3075.6
Total	RM 29383.2	RM 36907.2
	RM 7524/ year RM 627/ month	

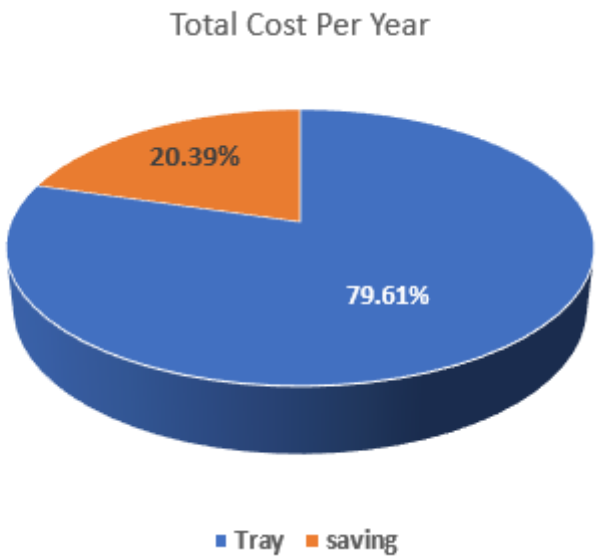


Figure 15: Pie chart for total cost per year

5. CONCLUSION

In conclusion, this research study proves that the improved process from the conveyor system to the manual tray system can reduce the preheat cycle time with the exception of few processes of work elements as it saves 19.8 % of cycle time.

Moreover, the research on temperature drop compares the heat loss when using 2 doors oven versus 1 door oven. It can be concluded that 23.31% of temperature drop at the preheat section was demonstrated in the new proposed layout. Therefore, the cost reduction of electric can be saved 20.39% for tray process.

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KAJIAN KEBERKESANAN PENGGUNAAN IJUK KABUNG SEBAGAI BAHAN PENAPIS DALAM MENURUNKAN NILAI pH DAN NILAI KEKERUHAN EFLUEN DI KILANG MASTER WAN BATEK, DENGKIL

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ABSTRAK

Industri batik semakin mendapat sambutan dan tempat di persada industri tempatan mahu pun antarabangsa. Kepesatan perkembangan dan permintaan terhadap industri batik sedikit sebanyak turun menyumbang kepada pencemaran alam sekitar apabila sisa efluen akhir batik tersebut dibuang terus ke dalam sungai. Tujuan kajian ini adalah untuk merekabentuk satu alat yang boleh membantu pengusaha industri batik dalam memastikan sisa akhir efluen mematuhi kehendak peraturan daripada Jabatan Alam Sekitar sebelum dilepaskan ke sungai. Kajian ini dibuat bersama dengan pengusaha batik iaitu Encik Wan Mahtar Bin Wan Salleh di Kilang Master Wan Batik, Dengkil, Selangor Darul Ehsan. Penapis Saliran Efluen direka untuk menapis sisa efluen batik yang akan dilepaskan ke sungai. Efluen yang terhasil dari kilang batik adalah terdiri daripada pewarna, lilin dan rosin. Efluen ini perlu ditapis kerana jika tidak ditapis,efluen yang terhasil akan menjadi racun atau membentuk kepada pepejal di samping menyumbang kepada peningkatan bilangan sungai yang tercemar. Penapis Saliran Efluen ini digunakan bagi mengurangkan kekeruhan air sungai untuk mencapai nilai pH yang telah ditetapkan oleh Jabatan Alam Sekitar dan boleh membantu pengusaha industri kilang batik mempunyai kaedah yang sistematik dalam melepaskan sisa efluen batik mereka. Sisa efluen yang akan dilepaskan ke sungai mestilah mematuhi peraturan iaitu mencapai pH antara 6.0-9.0 dan tahap kekeruhan 0-40 NTU. Bahan yang digunakan sebagai penapis ini ialah pasir halus, ijuk kabung, sabut kelapa, arang, batu kerikil, batu terumbu karang. Kesimpulannya, jika Penapis Saliran Efluen ini diaplikasikan di kilang-kilang batik, kadar pencemaran sungai yang disebabkan oleh industri batik secara tidak langsung dapat diturunkan.

Key Words : *Efluen, Batik, NTU, Ijuk Kabung*

1. PENGENALAN

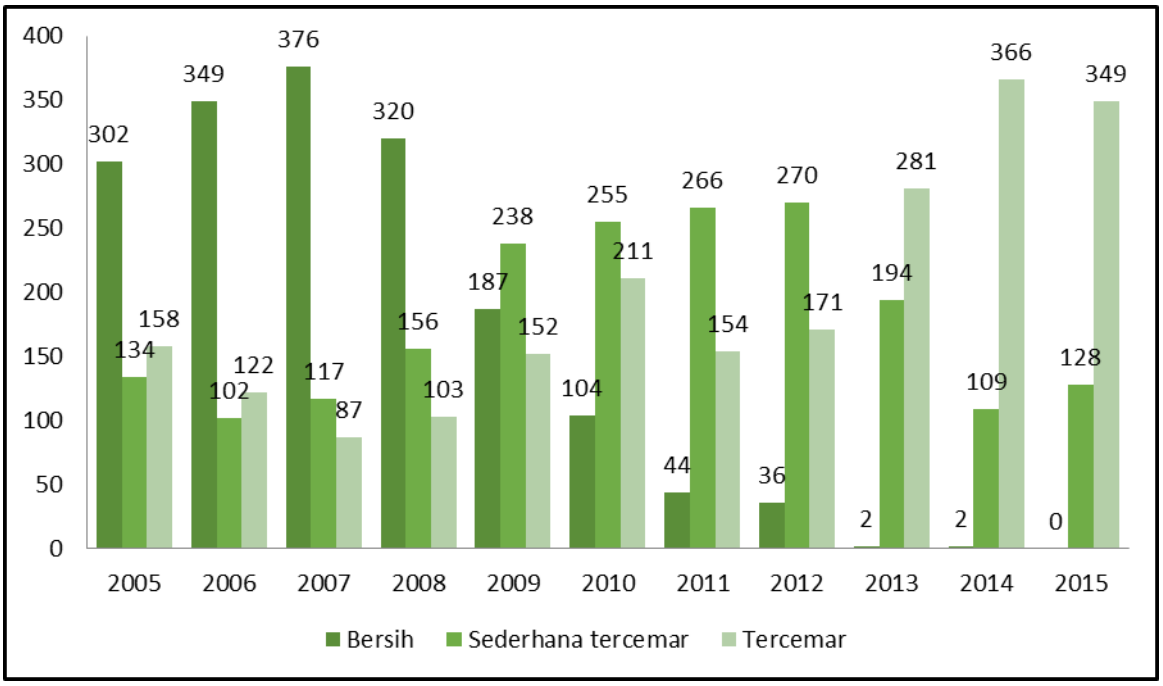
Batik berasal dari perkataan Jawa 'amba' yang bermakna menulis, dan 'nitik' yang bermakna membuat titik. Batik yang dipercayai berasal dari Indonesia, adalah satu seni reka corak yang berasaskan lilin sebagai bahan halangan untuk menghasilkan corak (Sumber: Malaysian Standard, MS 692:2007).

Bersumberkan kepada Batik Malaysia (Kraftangan) di dalam Malaysian Standard Perkara 3.1 (definisi batik) MS 692:2007 (Jabatan Standard Malaysia), kain batik adalah kain yang diproses dengan melukis, mencetak, mewarna, mencelup fabrik menggunakan bahan halangan fizikal ke atas fabrik seperti lilin, untuk mengelakkan bahagian yang diaplikasikan oleh lilin tersebut daripada diresapi warna dan kemudiannya melupuskan bahan halangan fizikal (lilin) tersebut untuk menampakkan coraknya. Seterusnya, terdapat beberapa jenis batik yang diproses oleh pengusaha-pengusaha batik pada hari ini. Di antaranya adalah Batik Lukis, Batik Terap dan Batik Sutera Saring. Kebiasaannya reka corak dan motif-motif batik diinspirasikan dari alam semula jadi seperti flora dan fauna yang kemudiannya digabung dengan corak-corak geometri atau abstrak. (Kraftangan).

Di Malaysia, batik merupakan seni warisan bangsa yang menjadi kebanggaan negara. Batik mula diperkatakan di Malaysia pada abad ke-17 Kesultanan Melayu. Lagenda bermula apabila Laksamana Hang Nadim menerima titah daripada Sultan Melaka, Sultan Mahmud untuk belayar ke India bagi membeli 140 helai serasah *'cloth*' (batik) yang dilakar dengan 40 jenis motif bunga. Namun kerana tidak berjaya menemui batik yang dikehendaki oleh Sultan, beliau menghasilkan kain batiknya sendiri. Dalam perjalanan pulang, kapal beliau karam dan hanya 4 helai batik berjaya di bawa pulang yang menimbulkan kemarahan Sultan. Di Terengganu, pembuatan batik bermula pada tahun 1913 dengan lukisan menggunakan lilin. Manakala di Kelantan, batik mula dihasilkan di Lorong Gajah Mati, Kota Bharu. Pada zaman penjajahan Jepun,industri batik merudum apabila banyak kilang-kilang terpaksa ditutup. Namun, pada tahun 1957 Malaysia mewujudkan identiti batik kebangsaan dengan menjadikannya pakaian kebangsaan untuk majlis-majlis rasmi. Batik Malaysia kebanyakannya terdiri daripada motif bunga-bunga besar, ringan dan berwarna terang serta ceria.

Industri batik semakin mendapat sambutan dan tempat di persada industri tempatan mahu pun antarabangsa. Daripada industri batik ini juga sedikit sebanyak telah menyumbang peratus pencemaran terutamanya pada pencemaran air dan mencemarkan kualiti air sungai apabila efluen yang terhasil daripada proses pembuatan akhir

batik. Secara amnya, kami mengkaji dan cuba untuk mengurangkan tahap pencemaran yang berlaku akibat daripada pembuangan secara terus ke sungai sisa efluen yang dihasilkan daripada kilang batik. Mengikut daripada statistik yang telah dikeluarkan oleh Jabatan Alam Sekitar, *Tren Kualiti Air Sungai Berdasarkan Sub-Indeks BOD (2005-2015), kadar bilangan air sungai yang bersih telah turun secara mendadak daripada tahun 2008 (376) sehingga 2014 (2) dan sehingga kini tiada lagi sungai yang bersih. Namun begitu, sehingga tahun 2015 bilangan air sungai yang tercemar telah mencecah sehingga 348 dan semakin bertambah dari tahun ke tahun. Secara tidak langsung, kami ingin merawat serta mengurangkan kadar populasi sungai yang tercemar dengan mencipta satu alat yang mudah dan juga bekerbesanan untuk kegunaan industri kilang batik di Malaysia.



Graf 1 : Tren Kualiti Air Sungai Berdasarkan Sub-Indeks BOD (2005-2015)
Sumber: Laporan Kualiti Alam Sekeliling Malaysia 2015

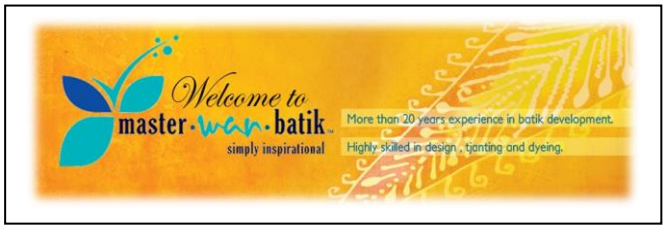
Industri batik merupakan salah satu industri tradisional yang turut menyumbang secara signifikan kepada ekonomi negara. Batik keluaran Malaysia mendapat permintaan yang tinggi dari pasaran tempatan dan luar negara kerana keunikannya. Walau bagaimanapun di sebalik keunikan ini, aktiviti pembuatan batik turut menghasilkan air sisa atau yang dikenali sebagai efluen yang menyumbang kepada masalah pencemaran air terutama di Kelantan dan Terengganu memandangkan penghasilan batik melibatkan penggunaan bahan kimia yang banyak. Kajian awal ke atas airsisa yang dihasilkan oleh premis pembuatan batik menunjukkan bahawa efluen yang terhasil dari aktiviti pemprosesan batik mengandungi pepejal terampai, pewarna organik dan bukan organik serta logam berat yang memberi kesan negatif kepada alam sekitar. Selain pencemaran air, aktiviti pembuatan batik yang tidak mesra alam juga menimbulkan masalah pencemaran udara dan penghasilan sisa buangan.

Di bawah Peraturan-Peraturan Kualiti Alam Sekeliling (Efluen Perindustrian) 2009, Akta Kualiti Alam Sekeliling 1974, Peraturan 8(1) Seseorang pemunya atau penghuni sesuatu premis hendaklah mengendalikan dan menyenggara sistem pengolahan efluen perindustrian atau efluen bercampur dan memastikan semua komponen sistem pengolahan efluen perindustrian dalam keadaan baik. Dan Peraturan 8(2) pula menerangkan bahawa, Dalam peraturan ini, “amalan kejuruteraan yang baik” ertinya cara yang dengannya sistem pengolahan efluen perindustrian dikendalikan yang ciri-ciri pengendalian disenggarakan dalam nilai julat normal yang biasa digunakan bagi pengolahan efluen perindustrian atau efluen bercampur. Ini jelas tentang keperluan pemunya premis perindustrian (dalam konteks ini industri batik) untuk memastikan nilai julat normal bagi efluen yang terhasil perlulah dipatuhi sebelum dilepaskan atau dilupuskan.

2. LATAR BELAKANG KAJIAN / PERNYATAAN MASALAH

Kilang batik yang menjadi kajian kami terletak di Dengkil, Selangor dan diuruskan oleh En.Wan Mahtar yang telah beroperasi sejak 1989 sehingga kini. Purata kadar pengeluaran produk yang dihasilkan oleh kilang ini adalah sebanyak 50 helai dalam tempoh masa seminggu. Anggaran bagi penghasilan sisa efluen yang terhasil daripada pembuatan tersebut adalah sebanyak 100 liter. Seterusnya, sisa efluen yang terkumpul selama dua minggu akan terus dibuang ke longkang berdekatan tanpa sebarang penapis. Sisa efluen yang dibuang di longkang itu akan terus ke sungai yang berdekatan iaitu Sungai Dengkil.

Kilang Master Wan Batek mula beroperasi daripada tahun 1989 hingga sekarang yang dimilik oleh pengusaha batik bumiputra iaitu En Wan Mahtar bin Wan Salleh. Premisnya beralamat di No 2, Taman Ambar, 43800 Dengkil, Selangor. Kadar pengeluaran batik adalah sekitar 50 helai batik sutera dalam seminggu dan anggaran kapasiti sisa efluen adalah sebanyak 100liter bagi setiap DUA (2) minggu. Setiap DUA (2) minggu, sisa efluen akan dilepaskan secara terus ke longkang berdekatan premis yang mana akan mengalir ke sungai yang berdekatan iaitu Sungai Langat tanpa dirawat terlebih dahulu.



Rajah 1 : Logo Kilang Master Wan Batek

Rajah 2 : Proses membuat batik oleh En Wan Mahtar Bin Wan Salleh

Pokok Kabong *(Arenga pinnata)* merupakan tumbuhan dari keluarga Arecaceae yang terdapat di Malaysia, Indonesia dan Filipina yang boleh menghasilkan manisan. Pokok ini juga dipanggil sebagai Sugar Palm, Arenga Palm, Areng palm, Black-fiber palm, Gomuti Palm, Pokok Aren, Pokok Enau, Irok dan Pokok Kaong. Pokok Kabung ialah sejenis pokok palma yang mempunyai daun bagaikan 'Bulu burung'. jika dilihat dari kejauhan *(Lihat foto sebelah).* Ini disebabkan susunan daunnya yang melempai kebawah dari pelepah daun dengan kelihatan meurun seperti bulu burung merak atau burung kawasari. Batang pokok Kabong seperti pokok Arecaceae lain adalah berdiri kukuh dimana ia mempunyai pelepah pada pangkal setiap daun. Pelepah ini mempunyai serat hitam yang boleh juga digunakan untuk membuat penyapu dan tali. Serat hitam ini sangat kuat sehingga boleh digunakan sebagai tali. Oleh itu, penggunaan ijuk kabung sebagai salah satu bahan di dalam penapis telah dipilih kerana tahan lasak dan tidak memerlukan penyenggaraan berkala dalam tempoh yang kerap.

Kajian penggunaan ijuk kabung atau nama saintifiknya *'Arenga Pinnata Merr'* sebagai salah satu komposisi di dalam penapis yang digunakan untuk menapis sisa efluen sebagai satu kaedah merawat efluen batik tersebut sebelum dilepaskan ke sungai adalah merupakan objektif utama di dalam kajian kes ini. Ijuk Kabung adalah satu tunbuhan yang datang daripada timur India ke Malaysia, Indonesia dan hingga ke timur Filipina. Ia hampir menyerupai pokok kelapa sawit yang bersaiz sederhana, boleh berkembang sehingga 20m tinggi dengan batang yang masih ditutup oleh dasar daun tua yang kasar. Panjang daun sekitar 6 hingga 12m dan lebar hampir 1.5m. Komposisi ijuk kabung di dalam penapis adalah sebanyak 65% daripada keseluruhan komposisi penapis tersebut. Komposisi bahan lain yang terdapat di dalam penapis adalah pasir halus bersaiz kurang daripada 5mm, arang, sabut kelapa dan batu kerikil halus bersaiz 5 hingga 15mm.

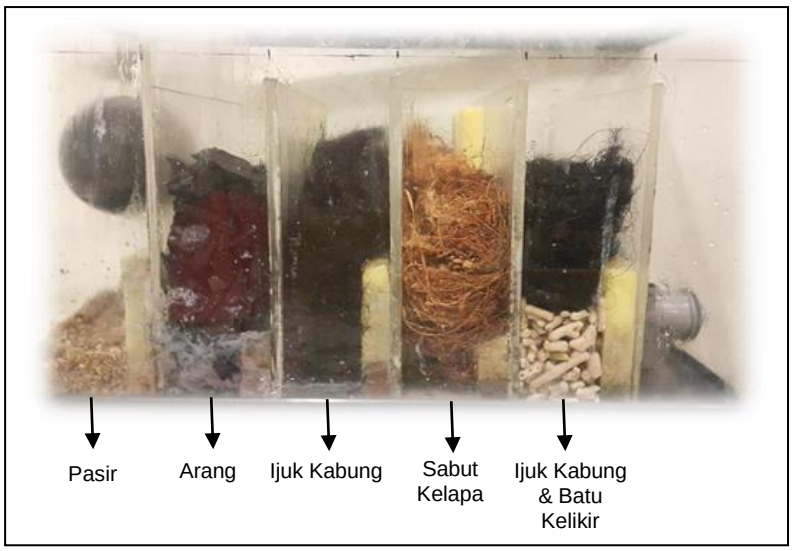
Rajah 3 : Ijuk Kabung atau *'Arenga pinnata Merr'*

Rajah 4 : Pasir halus

Rajah 5 : Arang

Rajah 6 : Sabut kelapa

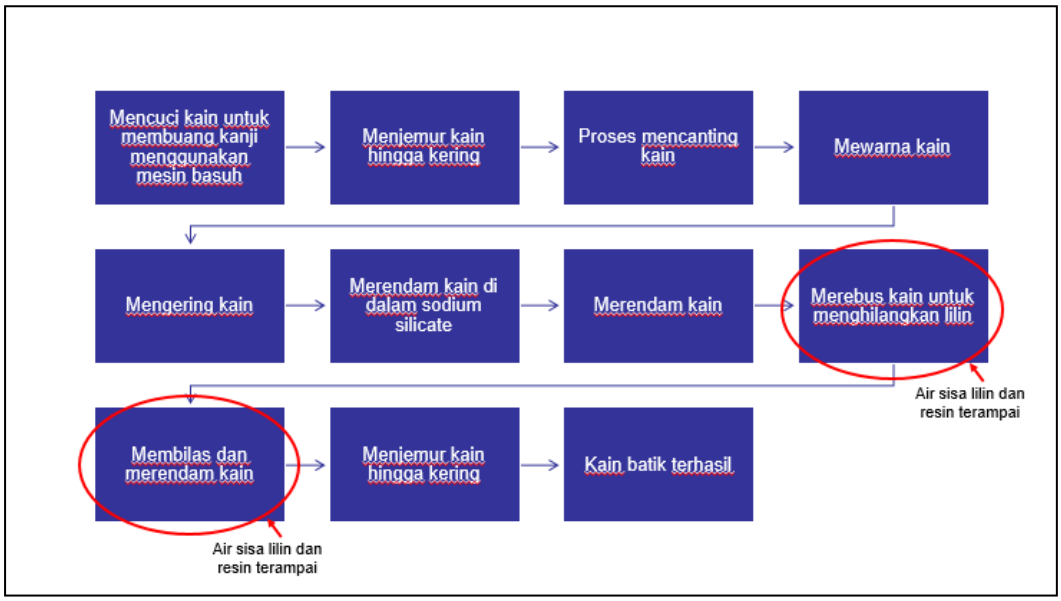
Rajah 7 : Kelikir Halus



Rajah 8 : Penapis Saliran Efluen yang direka untuk menurunkan nilai kekeruhan dan nilai pH yang terdiri daripada pasir, arang, ijuk kabung, sabut kelapa dan batu kelikir

Semua efluen yang terkumpul merupakan air sisa lilin dan resin terampai selepas kain batik terhasil dikumpulkan dalam satu tangki efluen dan daripada tangki tersebut, efluen akan dialirkan masuk ke dalam penapis saliran efluen dan hasil tapisan tersebut dialirkan ke ruang untuk aliran ke longkang. Sampel hasil tapisan tersebut diambil dan diuji untuk mendapatkan nilai kekeruhan dan nilai pHnya.

Efluen yang dihasilkan dari pemprosesan batik mempunyai ciri-ciri seperti beralkali, berwarna dan mempunyai suhu yang tinggi. Bahan kimia yang digunakan di dalam pemprosesan batik ialah lilin, resin, sodium silicate dan bahan pewarna (organik dan bukan organik). Terdapat lebih daripada 100,000 bahan pewarna komersial di pasaran dengan kadar pengeluaran bahan pewarna sebanyak 7x105 tan setahun. Berdasarkan kepada struktur kimianya, pewarna mempunyai rintangan terhadap kepudaran apabila terdedah kepada cahaya, air dan bahan kimia lain. Struktur yang kompleks pula menyebabkan pewarna sukar untuk nyahwarna dan mereput secara biologi. Proses pembuatan batik dipermudahkan dalam bentuk carta alir seperti di bawah :



Carta 1 : Proses Pembuatan Batik di Kilang Master Wan Batek, Dengkil, Selangor

Melalui hasil kajian kami, peningkatan kadar pencemaran sungai semakin meningkat dari tahun ke tahun. Salah satu penyumbang kepada peningkatan kadar bilangan pencemaran sungai ini adalah pelepasan sisa efluen secara terus ke sungai yang terhasil daripada proses pembuatan batik dari kilang batik. Antara permasalah yang dihadapi ialah :

i) Tiada kaedah yang sistematik untuk mengalirkan sisa efluen yang terhasil daripada kilang batik untuk dilepaskan terus ke sungai yang terdekat

ii) Mencemarkan sungai serta seterusnya menyumbang kepada pengurangan bilangan sungai yang bersih di Malaysia; dan, akhirnya
iii) Sedikit sebanyak telah memberi impak kepada para nelayan yang telah menjadikan sungai sebagai sumber rezeki dan mengancam kehidupan marin.

Sehingga kini, pelbagai kajian telah dijalankan bagi mendapatkan kaedah dan pendekatan terbaik dalam merawat efluen batik. Salah satu pendekatan yang diambil adalah melalui pelaksanaan opsyen-opsyen CP yang menyeluruh dan bersepadu (comprehensive and integrated). Bagi aspek penjanaan efluen pula, pelaksanaan CP dapat mengurangkan kuantiti air sisa yang terjana di mana strategi-strategi CP memfokuskan kepada mengenalpasti sumber-sumber pencemar dan kuantiti penjanaan, seterusnya melaksanakan konsep pencegahan (pollution prevention) bagi mengurangkan kandungan dan kuantiti bahan pencemar tersebut. Paling ketara ialah pengurangan/pengoptimuman penggunaan setiap jenis sumber iaitu air dan bahan kimia. Namun begitu, industri batik masih juga memerlukan satu sistem yang dapat merawat efluen batik. Pada masa ini, sistem rawatan berpusat adalah tidak sesuai dilaksanakan bagi premispremis batik di Kelantan. Ini adalah kerana lokasi premis-premis pembuatan batik tersebut adalah bertaburan dan usaha untuk mengumpul semua premis dalam bentuk kluster adalah mustahil. Satu sistem rawatan mini diperlukan kerana industri pembuatan batik adalah industri cottage dan kebanyakkan premis dibina di dalam ruang yang terhad. Selain itu, rekabentuk sistem rawatan juga perlu mengambil kira kuantiti dan ciri-ciri air efluen yang terjana bagi sesebuah premis. Pada masa kini, terdapat pelbagai teknologi rawatan bagi merawat efluen yang terhasil dari aktiviti pembuatan batik seperti berikut:

- Penjerapan pada karbon teraktif (carbon adsorption)
- Rawatan ozon
- Proses membran (turasan ultra, mikro,nano,osmosis berbalik)
- Proses elektrokimia
- *'Coagulation'* dan *'Flocculation'*

Industri batik merupakan salah satu industri tradisional yang turut menyumbang secara signifikan kepada ekonomi negara. Batik keluaran Malaysia mendapat permintaan yang tinggi dari pasaran tempatan dan luar negara kerana keunikannya. Walau bagaimanapun di sebalik keunikan ini, aktiviti pembuatan batik turut menghasilkan air sisa atau yang dikenali sebagai efluen yang menyumbang kepada masalah pencemaran air terutama di Kelantan dan Terengganu memandangkan penghasilan batik melibatkan penggunaan bahan kimia yang banyak. Kajian awal ke atas airsisa yang dihasilkan oleh premis pembuatan batik menunjukkan bahawa efluen yang terhasil dari aktiviti pemprosesan batik mengandungi pepejal terampai, pewarna organik dan bukan organik serta logam berat yang memberi kesan negatif kepada alam sekitar. Selain pencemaran air, aktiviti pembuatan batik yang tidak mesra alam juga menimbulkan masalah pencemaran udara dan penghasilan sisa buangan.

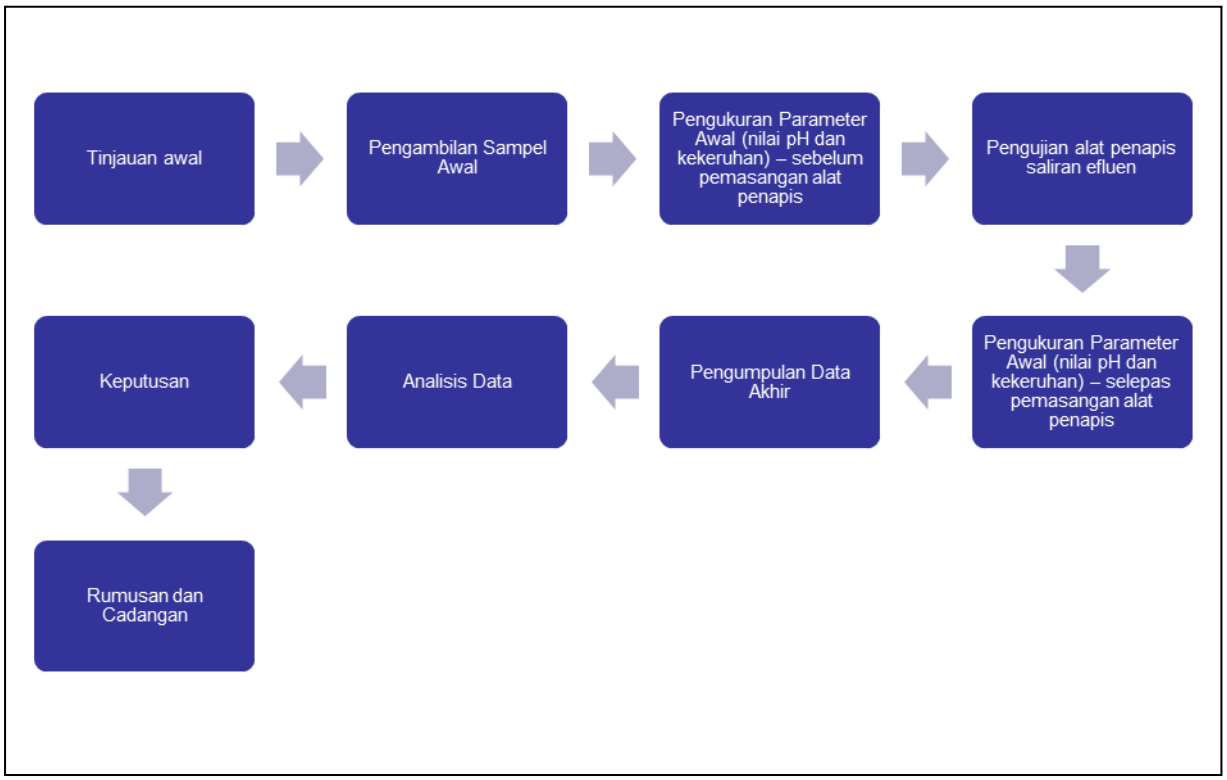
3. OBJEKTIF KAJIAN

Melalui kajian yang kami lakukan, kami telah menetapkan beberapa objektif yang harus kami capai dalam memastikan keberkesanan dan kesesuaian dalam menghasilkan projek kami dan boleh diterima pakai dalam industri kilang batik. Objektif yang ditetapkan ialah:
i) Mengkaji keberkesanan penggunaan bahan ijuk kabung sebagai salah satu bahan di dalam penapis saliran efluen dalam menurunkan nilai kekeruhan dan nilai pH efluen daripada Kilang Master Wan Batek, Dengkil; dan,
ii) Mengenalpasti parameter yang dicapai oleh penapis saliran efluen tersebut mencapai piawaian standard yang dibenarkan oleh Jabatan Alam Sekitar.

Melalui projek kami ini, selain daripada perlu mencapai objektif serta menyelesaikan masalah yang dihadapi. Kepentingan kajian juga perlu diambil kira dalam memastikan projek kami ini berjaya dan boleh digunapakai dalam industri. Kepentingan kajian kami termasuklah :
iii) Pencemaran sungai dari hasil pembuangan efluen dari kilang batik dapat dikurangkan; dan,
iv) Ekosistem hidupan di sungai lebih terjaga dan hidupan sungai kurang terancam dengan bahan kimia yang dilepaskan.

4. METHODOLOGI

Carta 2 menunjukkan Kaedah Metodologi yang digunakan untuk mencapai objektif dan matlamat kajian ini. Dalam tinjauan awal, permasalahan dikenalpasti dengan melakukan soal selidik dengan pengusaha kilang Master Wan Batek tersebut. Sampel awal diambil dan nilai pH serta nilai kekeruhan diuji di makmal untuk mendapatkan data awal kajian. Dalam masa itu, alat penapis saliran efluen dibangunkan dan diuji dengan menggunakan sampel awal yang diambil. Komposisi bahan di dalam penapis disesuaikan dan ditukar dari masa ke semasa sehingga mendapat bacaan parameter nilai pH dan nilai kekeruhan yang mematuhi nilai *'Water Quality Index' (WQI)* yang benarkan oleh Jabatan Alam Sekitar. Selepas mendapat nilai bacaan yang memenuhi parameter tersebut, pemasangan alat penapis saliran efluen dilaksanakan di kilang Master Wan Batek.



Carta 2 : Kaedah metodologi kajian Penapis SE

Data dikumpul kembali dan dianalisis untuk mendapatkan keputusan hasil kajian penggunaan Ijuk Kabung sebagai komposisi utama di dalam penapis saliran efluen ini. Analisis data dilaksanakan di Makmal Alam Sekitar, Jabatan Kejuruteraan Awam, Politeknik Sultan Salahuddin Abdul Aziz Shah. Rumusan dan cadangan dilaksanakan selepas keputusan bacaan nilai pH dan nilai kekeruhan mematuhi keperluan yang telah ditetapkan oleh pihak Jabatan Alam Sekitar.

5. KEPUTUSAN DAN PERBINCANGAN

Jadual 1 menunjukkan nilai parameter WQI yang telah ditetapkan oleh Jabatan Alam Sekitar Malaysia. Nilai parameter yang ingin dicapai di dalam kajian ini perlu berada di dalam kelas IIA atau kelas I sebelum efluen tersebut dilepaskan ke sungai. Jadual 2 pula menunjukkan kelas-kelas air dan kegunaannya yang mana untuk kajian ini disasarkan berada dalam lingkungan Kelas I atau IIA.

PARAMETER	UNIT	CLASS					
		I	IIA	IIB	III	IV	V
pH	-	6.5 – 8.5	6 – 9	6 – 9	5 – 9	5 – 9	–
Turbidity	NTU	5	50	50	–	–	–

Jadual 1 : ***National Water Quality Standards For Malaysia***

CLASS	USES
CLASS I	Conservation of natural environment. Water Supply I - Practically no treatment necessary. Fishery I - Very sensitive aquatic species.
CLASS IIA CLASS IIB	Water Supply II - Conventional treatment. Fishery II - Sensitive aquatic species. Recreational use body contact.
CLASS III	Water Supply III - Extensive treatment required. Fishery III - Common,of economic value and tolerant species; livestock drinking.
CLASS IV	Irrigation
CLASS V	None of the above

Jadual 2 : ***National Water Quality Standards For Malaysia***

Jadual 3 menunjukkan data awal yang diperolehi semasa tinjauan awal dilaksanakan di premis tersebut. Sampel efluen sebanyak 500ml daripada kilang diambil untuk tempoh 5 minggu berturut-turut dan bacaan nilai pH dicatatkan seperti jadual di bawah.

PERKARA	1	2	3	JULAT CIRI-CIRI EFLUEN BATIK
Minggu 1	10.80	10.90	10.90	10.87
Minggu 2	10.70	10.60	10.70	10.67
Minggu 3	10.40	10.00	9.90	10.10
Minggu 4	10.20	10.20	10.20	10.20
Minggu 5	9.20	8.20	8.00	8.46

Jadual 3 : Bacaan nilai pH di premis Master Wan Batek, Dengkil, Selangor

Manakala, Jadual 4 pula menunjukkan nilai kekeruhan daripada sampel yang sama diuji dan diambil untuk tempoh 5 minggu berturut-turut. Sampel tersebut diambil sebelum pemasangan penapis saliran efluen untuk menentukan data awal kajian ini.

PERKARA	1	2	3	JULAT CIRI-CIRI EFLUEN BATIK (NTU)
Minggu 1	97.70	98.20	98.60	98.20
Minggu 2	152.00	153.00	153.00	152.70
Minggu 3	87.40	87.40	87.50	87.43
Minggu 4	85.80	87.40	86.30	86.50
Minggu 5	129.00	128.00	127.00	128.00

Jadual 4 : Bacaan nilai kekeruhan di premis Master Wan Batek, Dengkil, Selangor

Apabila pemasangan penapis saliran efluen yang menggunakan ijuk kabung sebagai komposisi utamanya dipasang di premis tersebut, sampel efluen diambil untuk tempoh 3 minggu berturut-turut dan diuji di Makmal Alam Sekitar, Jabatan Kejuruteraan Awam, Politeknik Sultan Salahuddin Abdul Aziz Shah, Shah Alam, Selangor. Jadual 5 menunjukkan bacaan parameter nilai pH dan nilai kekeruhan yang diambil selepas pemasangan penapis tersebut.

PERKARA	1	2	3	JULAT CIRI-CIRI EFLUEN BATIK (NTU)	Nilai parameter mengikut WQI
Nilai pH	4.80	4.60	4.60	4.67	6 – 9
Nilai kekeruhan (NTU)	38.70	31.30	30.70	33.57	50

Jadual 4 : Bacaan nilai pH dan kekeruhan di premis Master Wan Batek, Dengkil, Selangor selepas pemasangan penapis

Berdasarkan hasil pengolahan data yang telah dilakukan, dapat disimpulkan bahawa hasil akhir efluen yang dirawat daripada alat penapis telah mencapai tahap piawaian yang ditetapkan oleh Jabatan Alam Sekitar sekaligus telah pun mencapai objektif kajian ini. Hasil air efluen yang keluar daripada penapis tersebut mengalami penurunan daripada segi kekeruhan iaitu kekurangan dalam kepekatan warnanya dan juga nilai pH yang telah berubah menurun. Pemerhatian secara visual turut mendapati warna efluen turut berubah menjadi lebih jernih berbanding sebelum dirawat. Ini dapat dilihat seperti Rajah 9 di bawah.

Rajah 9 : Efluen yang diambil sebelum pemasangan penapis (sebelah kiri) dan efluen yang diambil selepas pemasangan penapis (sebelah kanan)

6. KESIMPULAN

Berdasarkan hasil pengolahan data yang telah dilakukan, kami dapat simpulkan bahawa hasil air efluen yang keluar daripada alat penapis telah berjaya mencapai tahap piawaian yang ditetapkan oleh Jabatan Alam Sekitar sekaligus telah pun mencapai objektif kami. Hasil air efluen yang keluar daripada penapis tersebut telah pun mengalami kekurangan daripada segi kekeruhan iaitu kekurangan dalam kepekatan warnanya dan juga nilai pH yang telah berubah menurun. Di samping itu juga, kami berjaya mencipta penapis yang kecil dan mudah untuk dipasang dan diselenggara seterusnya menepati citarasa para pengusaha industri batik.

PENGIKTIRAFAN

Penapis Saliran Efluen telah mendapat pengiktirafan *"Golden Award"* di *Final Projek Civil Engineering (FPCE)* pada sesi Jun 2017. Ini melayakkan kajian ini dipertandingkan di *"INVENTION & INNOVATION TECHNOLOGY EXPOSITION"* pada sesi yang sama di peringkat Politeknik Sultan Salahuddin Abdul Aziz Shah, Shah Alam.

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KAJIAN PERSEPSI PELAJAR TERHADAP BUKU MODUL NOTA & LATIHAN DBM 1013 *BASIC ALGEBRA*

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ABSTRAK

Kursus Matematik Kejuruteraan 1 dengan adalah merupakan kursus yang wajib diambil oleh semua pelajar program diploma kejuruteraan pada semester satu., Buku modul nota dan latihan DBM 1013 Basic Algebra telah dihasilkan oleh para pensyarah untuk dijadikan bahan P&P dan diwajibkan penggunaannya kepada semua pelajar semester satu yang mengambil kursus ini. Untuk memastikan bahawa buku modul yang dihasilkan adalah berkualiti dan menepati keperluan pelajar satu kajian untuk meninjau persepsi pelajar terhadap buku modul tersebut telah dilaksanakan. . Instrumen kajian ini adalah borang soal selidik yang terdiri daripada 3 bahagian utama iaitu bahagian A meninjau persepsi terhadap kandungan, bahagian B meninjau persepsi terhadap nota dan latihan dan bahagian C meninjau persepsi terhadap persembahan. Kajian rintis telah dijalankan untuk pengesahan dan seramai 80 orang pelajar telah menjadi responden kepada kajian. Berdasarkan kepada hasil dapatan skor min bagi ketiga bahagian tersebut adalah 4.44, 4.37 dan 4.12. ini bermakna para pelajar bersetuju dengan ciri-ciri yang telah dimasukkan di dalam tinjauan yang dilakukan. Walaupun begitu, daripada hasil dapatan tersebut dapat membantu para pensyarah untuk melakukan penambahbaikan dalam menghasilkan buku yang lebih berkualiti pada masa akan datang.

KATA KUNCI: *Matematik Kejuruteraan 1, persepsi pelajar, buku modul*

1.0 PENGENALAN

Penggunaan bahan pengajaran dan pembelajaran (P&P) mampu menjadikan sesuatu proses pengajaran dan pembelajaran menjadi lebih berkesan kepada pelajar. Menurut Ahmad Zanzali, N.A & Daud, N.D (2010) variasi dalam bahan bantu mengajar adalah aspek penting yang perlu diberi perhatian untuk menarik minat pelajar dan mempertingkatkan kefahaman mereka semasa proses pengajaran dan pembelajaran. Penggunaan buku dilihat sebagai salah satu kaedah yang konvesional namun begitu, penggunaannya mampu membawa impak yang positif kepada pelajar. Peranan buku modul nota dan latihan DBM 1013 *Basic Algebra* adalah sama dengan peranan buku teks yang digunakan di sekolah. Kesemua pelajar semester satu diwajibkan untuk mempunyai buku modul DBM 1013 sebagai rujukan utama P&P. Buku modul DBM 1013 ini diolah secara bersepadu dengan menggabungkan nota dan latihan mengikut sub topik dalam Matematik Kejuruteraan 1 (DBM1013). Menurut Prastowo (2012) buku teks merupakan bahan bantu mengajar yang mempunyai kepelbagaian fungsi di dalam kelas antaranya ialah sebagai sumber rujukan, penilaian, pelaksana kurikulum dan penentu mod serta teknik pengajaran yang akan dilaksanakan oleh guru-guru.

Kursus Matematik Kejuruteraan 1 dengan adalah merupakan kursus yang wajib diambil oleh semua pelajar program diploma kejuruteraan pada semester satu. Kursus ini terdiri daripada 4 topik utama iaitu Asas Algebra, Trigonometri, Nombor Kompleks, Matriks dan Vektor dan Skalar. Setiap pelajar diwajibkan untuk memiliki lima buku modul berasingan mengikut sub topik yang berkenaan.

Buku modul seperti juga buku teks adalah merupakan bahan dan sumber pengajaran dan pembelajaran yang penting di dalam kelas. Oleh itu menurut UNESCO buku teks " *a book which is an exposition of generally accepted principles in one subject, intended primarily as a basis for instruction in classroom or pupil-book-teacher situation*" (Abdul Rahman Mahamad, 2001, hlm 2). Menurut Qhairunnisa (2015), buku teks yang dihasilkan haruslah mempunyai kualiti dan isi kandungan yang tepat kerana buku teks merupakan medium penyampaian maklumat yang berkesan sekaligus memainkan peranan penting dalam penyebaran ilmu kepada para pelajar. Oleh itu adalah perlu untuk meninjau pandangan pelajar terhadap keberkesanan sesuatu buku yang digunakan dalam P&P untuk memastikan buku rujukan yang dihasilkan itu berkualiti dan mampu memenuhi kehendak kurikulum yang telah ditetapkan

Skop kajian adalah kepada buku modul Nota dan Latihan DBM1013 *Basic Algebra* dan seramai 80 orang pelajar semester 1 telah digunakan sebagai responden untuk menjawab soal selidik impak dan keberkesanan.Objektif utama kajian ini ialah melakukan soal selidik terhadap 80 orang responden yang terdiri daripada pelajar semester 1 dan menganalisa dapatan dan keputusan yang akan diperolehi dengan melihat kepada min skor.

2.0 SOROTAN KAJIAN

Salah satu cara untuk melatih pelajar agar dapat membiasakan diri dengan soalan peperiksaan adalah melakukan sebeberapa banyak latih tubi. Dengan latih tubi pelajar dapat mengenalpasti bahagian-bahagian penting dan selalu ditanya dalam peperiksaan. Menurut Abdul Ghani Awang (1996), terdapat beberapa panduan untuk melakukan latih tubi soalan soalan yang lepas iaitu soalan hendaklah dijawab mengikut kehendak soalan, menepati masa yang telah diperuntukkan, melakukan latihan sekali seminggu, dan langkah menjawab perlu disusun dalam bentuk nota yang mudah digunakan semula. Selain itu, para pelajar perlu berjumpa dengan pensyarah untuk memastikan sejauh mana jawapan yang telah diberi adalah tepat mengikut kehendak soalan.

Menurut (Nawawi, 2005) (Salleh, 2010) latihan yang berulang adalah merupakan ciri penting dalam kaedah pembelajaran. Pengulangan sesuatu latihan dapat membawa kepada kesempurnaan dalam penyelesaian sesuatu soalan. Semakin kerap sesuatu latihan itu dilakukan maka semakin kukuh dan mahir seseorang individu itu dalam sesuatu keadah yang dilatihkan. Menurut Abdul Razak Idris dan Nor Asmah Salleh,(2010) bidang matematik memerlukan latih tubi untuk menguasai sesuatu kaedah. Proses P&P tidak boleh dilaksanakan dengan hanya mendengar secara lisan sahaja.

Buku modul Nota dan Latihan DBM 1013 *Basic Algebra* adalah merupakan sebuah buku modul yang terdiri daripada beberapa subtopik iaitu Asas Algebra, Penyelesaian Persamaan Kuadratik dan Pecahan Separa. Buku ini telah digunakan sebagai rujukan dalam P&P oleh semua pelajar semester satu yang mengambil kursus DBM 1013. Menurut Kamus Dewan Edisi Keempat (2005) buku teks bermaksud buku yang digunakan oleh pelajar sebagai rujukan yang standard untuk sesuatu mata, oleh itu, dapat dikaitkan buku nota dan latihan DBM 1013 *Basic Algebra* ini dengan penilaian yang dilakukan teradap buku-buku teks yang digunakan untuk P&P di sekolah. Menurut Marohaini Yusoff, Abd Murad Salleh & Sharir Jamaluddin (2005) menegaskan penilaian mutu dan kualiti sesuatu buku adalah merupakan salah satu aspek yang sangat penting. Mereka berpendapatan aspek kualiti yang perlu dititikberatkan adalah penggunaan bahasa, rekabentuk soalan dan grafik. Ketiga-tiga aspek ini akan memberi kesan dan mempengaruhi minat pelajar dalam menggunakan sesuatau buku. Oleh yang demikian penilaian terhadap aspek mutu dan kualiti adalah berkait rapat dengan penggunaan buku teks.

3.0 METODOLOGI KAJIAN

Menurut Sabitha Marican (2006), soal selidik yang mempunyai indeks kepercayaan bersamaan atau melebihi 0.7 boleh digunakan sebagai item pengukuran dalam sesuatu kajian. Item-item yang mempunyai kurang daripada 0.7 adalah kurang sesuai dan memerlukan pengubahsuaian. Ujian dijalankan berdasarkan Alpha Cronbach dengan menggunakan perisian Statistical Package for the social science (SPSS). Kajian rintis telah dilakukan terhadap 20 orang pelajar untuk menguji kebolehpercayaan soal selidik. Hasil keseluruhan kajian rintis adalah α=0.849. Ini menunjukkan instrument soal selidik yang digunakan adalah bersesuaian.

Kajian yang berbentuk tinjauan ini dijalankan secara kuantitatif. Soal selidik digunakan untuk mendapatkan data. Terdapat 89 orang pelajar Diploma Kejuruteraan Awam pada sesi Jun 2018. Kesemua pelajar ini menggunakan buku modul Nota dan Latihan DBM 3013 *Basic Algebra* dalam proses P&P mereka. Daripada keseluruhan pelajar ini, 80 orang bersetuju untuk menjadi responden soal selidik maklumbalas buku ini.

Borang soal selidik yang digunakan sebagai instrumen kajian melibatkan 3 bahagian utama iaitu bahagian A: Persepsi pelajar terhadap kandungan buku modul Nota dan Latihan DBM 1013 *Basic Algebra*, Bahagian B: Persepsi pelajar terhadap nota dan latihan DBM 1013 *Basic Algebra*, Bahagian C: Persepsi pelajar terhadap persembahan buku modul Nota dan latihan DBM 1013 *Basic Algebra*. Data data dianalisis dengan menggunakan perisian SPSS iaitu merujuk kepada nilai skor min. format skala Likert telah digunakan dalam soal selidik itu 1 hingga 5 (1= sangat tidak setuju dan 5= sangat setuju).

Jadual 1 : Soalan-soalan yang Digunakan dalam Borang Soal Selidik Bahagian A

No Soalan	A. Persepsi pelajar terhadap kandungan Buku Nota dan Latihan DBM 1013 *Basic Algebra*
1.	Isi kandungan memenuhi silibus yang telah diberikan di dalam Course Outline
2.	Mengandungi aspek pengetahuan yang hendak dikuasai oleh pelajar
3.	Fakta tepat dan terkini
4.	Penggunaan bahasa adalah mudah

Jadual 2: Soalan-soalan yang digunakan dalam Borang Soal Selidik Bahagian B

No Soalan	B. Persepsi pelajar terhadap nota dan latihan Buku Nota dan Latihan DBM 1013 *Basic Algebra*
1.	Menarik dan Kreatif
2.	Meransang dan mencabar
3. `	Praktikal, logical dan realistic
4.	relevan
5.	mudah dan jelas
6.	betul dan tepat
7.	menggalakkan penglibatan pelajar secara menyeluruh
8.	menepati keperluan untuk menghadapi peperiksaan akhir

Jadual 3: Soalan-soalan yang digunakan dalam Borang Soal Selidik Bahagian C

No. Soalan	c. Persepsi pelajar terhadap persembahan Buku Nota dan Latihan DBM 1013 *Basic Algebra*
1.	persembahan bahan mempunyai kesinambungan dan bertautan
2.	pengolahan bahan jelas dan sistematik
3.	mudah difahami dan mesra pengguna
4.	pelajar 6 berpeluang meningkatkan kemahiran secara berperingkat dan progresif
5.	pengolahan teks dan grafik bersepadu dan sesuai untuk menyampaikan pengetahuan
6.	rekabentuk buku konsisten pada keseluruhan buku

4.0 ANALISIS DAN KEPUTUSAN

4.1 Persepsi pelajar terhadap kandungan buku modul Nota dan Latihan DBM 1013 *Basic Algebra*
Pada umumnya para pelajar bepersepsi positif terhadap kandungan buku modul Nota dan Latihan DBM 1013 *Basic Algebra*. Min skor untuk bahagian ini ialah 4.44. ada dua respon yang tidak bersetuju dan sangat tidak bersetuju dalam penilaian aspek kandungan buku ini. Hasil kajian menunjukkan bahawa pelajar bersetuju bahawa isi kandungan buku nota dan latihan ini memenuhi keperluan silibus yang telah dinyatakan dalam course outline dengan min 4.46 dan mengandungi aspek pengetahuan yang hendak diketahui oleh pelajar dengan skor min sebanyak 4.55. pelajar juga bersetuju kandungan ini mempunyai fakta yang tepat dan terkini dengan skor min sebanyak 4.39. selain itu pelajar juga bersetuju bahawa penggunaan bahasa adalah mudah untuk diterima dengan skor min sebanyak 4.36

Jadual 4 : Hasil Dapatan Skor Min, Frekuensi dan Peratusan pada Bahagian A

No Soalan	Item	Sangat Setuju	Setuju	Kurang Setuju	Tidak Setuju	Sangat Tidak Setuju	Skor Min
1.	Isi kandungan memenuhi silibus yang telah diberikan di dalam *Course Outline*	43 (53.8%)	31 (38.8%)	6 (7.5%)	-	-	4.46
2.	Mengandungi aspek pengetahuan yang hendak dikuasai oleh pelajar	50 (62%)	24 (30%)	6 (7.5%)	-	-	4.55
3.	Fakta tepat dan terkini	37 (46.3%)	37 (46.3%)	6 (7.5%)	-	-	4.39
4.	Penggunaan bahasa adalah mudah diterima	43 (53.8%)	26 (32.9%)	9 (11.3%)	1 (1.3%)	1 (1.3%)	4.36

4.2 Persepsi pelajar terhadap Nota dan latihan buku modul Nota dan Latihan DBM 1013 *Basic Algebra*
Nota dan latihan adalah elemen atau komponen penilaian atau pentaksiran dalam buku ini bagi mengukuhkan penguasaan kandungan yang dipelajari oleh pelajar. Skor min untuk bahagian ini ialah sebanyak 4.37. Kebanyakkan pelajar kurang bersetuju bahawa buku ini menarik dan kreatif dengan skor min 4.29. pelajar sangat bersetuju nota dan latihan yang diberikan adalah meransang dan mencabar. Jika ditinjau dari segi praktikal, logikal dan realistik buku ini mendapat min sebanyak 4.45. pelajar juga bersetuju bahawa buku ini relevan dengan skor min 4.40, mudah dan jelas skor min 4.29 serta betul dan tepat skor min 4.38. buku ini dilihat boleh menggalakkan penglibatan pelajar secara menyeluruh dengan skor min 4.46 dan menepati keperluan mereka menghadapi peperiksaan akhir dengan skor min 4.58.

Jadual 5: Hasil Dapatan Skor Min, Frekuensi dan Peratusan pada Bahagian B

No Soalan	Item	Sangat Setuju	Setuju	Kurang Setuju	Tidak Setuju	Sangat Tidak Setuju	Skor Min
1.	Menarik dan Kreatif	20 (25%)	31 (37.5%)	27 (33.7%)	2 (2.5%)	-	3.86
2.	Meransang dan mencabar	48 (60%)	26 (32.5%)	5 (6.3%)	-	-	4.54
3. `	Praktikal, logical dan realistic	43 (53.8%)	30 (37.5%)	7 (8.8%)	-	-	4.45
4.	relevan	43 (53.8%)	26 (32.5%)	11 (13.8%)			4.40
5.	mudah dan jelas	36 (45%)	32 (40%)	11 (13.8%)	1 (1.3%)	-	4.29
6.	betul dan tepat	40 (50%)	31 (38.8%)	8 (10%)	1 (1.3%)	-	4.38
7.	menggalakkan penglibatan pelajar secara menyeluruh	45 (56.3%)	28 (35%)	6 (7.5%)	1 (1.3%)		4.46
8.	menepati keperluan untuk menghadapi peperiksaan akhir	50 (42.5%)	26 (32.5%)	4 (5%)	-	-	4.58

4.3 Persepsi pelajar terhadap persembahan buku modul Nota dan Latihan DBM 1013 *Basic Algebra*
Persembahan buku ialah pengolahan teks serta grafik yang menarik dan mudah difahami dalam penyampaian kandungan bagi tujuan P&P. Sebanyak 8 item digunakan untuk meninjau pandangan pelajar dalam bahagian ini. Hasil kajian mendapati skor keseluruhan bahagian ini ialah 4.12. kebanyakkan pelajar kurang bersetuju bahawa persembahan bahan mempunyai kesinambungan dan bertautan kerana min skor untuk bahagian ini ialah 3.74. selain tu, jika dilihat daripada segi pengolahan bahan jelas dan sistematik kebanyakkan pelajar kurang bersetuju dengan skor min sebanyak 3.91. Para pelajar bersetuju bahawa buku ini adalah mudah difahami dan mesra pengguna dengan skor min sebanyak 4.31 selain turut bersetuju buku ini dapat membuka peluang mereka meningkatkan kemahiran secara berperingkat dan progresif dengan skor min sebanyak 4.13. Buku ini juga didapati mempunyai pengolahan teks dan grafik bersepadu dan sesuai untuk menyampaikan pengetahuan kepada pelajar dengan skor min sebanyak 4.30 selain mempunyai rekabentuk buku yang konsisten pada keseluruhan buku dengan skor min 4.2.

Jadual 6 : Hasil dapatan Skor Min, Frekuensi dan Peratusan pada Bahagian C

No Soalan	Item	Sangat Setuju	Setuju	Kurang Setuju	Tidak Setuju	Sangat Tidak Setuju	Skor Min
1.	persembahan bahan mempunyai kesinambungan dan bertautan	10 (8%)	40 (50%)	29 (36.3%)	1 (1.3%)	-	3.74
2.	pengolahan bahan jelas dan sistematik	24 (30%)	29 (36.3%)	26 (32.9%)	1 (1.3%)	-	3.91
3.	mudah difahami dan mesra pengguna	36 (45%)	37 (46.3%)	6 (7.5%)	-	1 (1.3%)	4.34

4.	pelajar berpeluang meningkatkan kemahiran secara berperingkat dan progresif	32 (40%)	27 (33.8%)	20 (25%)	1 (1.3%)		4.13
5.	pengolahan teks dan grafik bersepadu dan sesuai untuk menyampaikan pengetahuan	34 (42.5%)	35 (43.8%)	10 (12.5%)	-	-	4.30
6.	rekabentuk buku konsisten pada keseluruhan buku	38 (47.5%)	31 (38.8%)	8 (10%)	2 (2.5%)	1 (1.3%)	4.2

5.0 KESIMPULAN

Menurut Duru (2006) '*Mean score of 1.00 to 1.49 were interpreted as strongly disagree whereas the mean score of 1.50 to 2.49 were interpreted as disagree. Besides, mean score of 2.50 to 3.49 were interpreted as less agree, mean score of 3.50 to 4.49 were interpreted as agree and mean score of 4.50 to 5.00 were interpreted as strongly agree '*, ini bermakna berdasarkan kepada kajian yang telah dijalankan kebanyakkan pelajar bersetuju bahawa kandungan buku modul Nota dan Latihan DBM1013 *Basic Algebra* mempunyai ciri ciri memenuhi silibus yang telah diberikan memenuhi silibus, mengandungi aspek pengetahuan yang hendak dikuasai, fakta tepat dan terkini dan bahasa yang digunakan adalah mudah. Selain itu, kebanyakkan pelajar juga bersetuju bahawa nota dan latihan yang diberikan adalah menarik dan kreatif, meransang dan mencabar, praktikal, logikal dan realistik, relevan, mudah dan jelas, betul dan tepat, menggalakkan penglibatan pelajar secara menyeluruh, menepati keperluan untuk mereka menghadapi peperiksaan akhir. Buku ini juga didapati telah dipersembahkan secara berkesinambungan dan bertautan, bahan yang jelas dan sistematik, mudah difahami dan mesra pengguna, memberi peluang meningkatkan kemahiran secara berperingkat dan progresif, pengolahan teks dan grafik bersepadu untuk penyampaian pengetahuan serta mempunyai rekabentuk yang konsisten pada keseluruhan buku.

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MINI PROJECT TEACHING CLASSROOM EXPERIENCES AT MALAYSIAN POLYTECHNICS: THE NEEDS OF MODULE IMPROVEMENT

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ABSTRACT

Skills in conducting, writing and presenting project report are essential for future engineering personnel. These skills are crucial in communicating new ideas and product innovation effectively since effective communication is one of the demanded skills by workplace industries towards industrial 4.0 revolution. Thus, this article presents mini-project teaching classroom experiences among lecturers at two polytechnics setting in Malaysia. This study employed a survey method using a set of open-ended questionnaire to seek relevant information on the mini-project teaching classroom experiences. Some of the questions asked are in terms of the lecturers' perceptions on the current teaching module used and the needs of module improvement. Thirteen lecturers volunteered as respondents. The findings showed that students are struggling to fulfil the mini-project requirement since they are not familiar with the skills and activities conducted in the project. The findings also showed that the modules used in classroom teaching supply insufficient information for conducting a mini-project such as step by step guidance to conduct the project. Other than that, the findings also revealed that guidelines on report writing should be precise and a standard report format should be provided. In conclusion, based on the findings of the study, the current module used should be embedded with specific information on how to carry out a mini-project and to complete a standard report. Thus, this study recommended developing a new mini-project module inclusive for polytechnic students.

KEYWORDS: *Mini-project, effective communication, polytechnic*

1. INTRODUCTION

The Industrial Revolution (IR) 4.0 has demanded us to change our attitudes, the way we work and communicate so that these changes could align us with the global trends. For instance, IR 4.0 has given an impact to the world education system to be relevant to the demanded situation. Consequently, a new model of education so-called Education 4.0 has been initiated (Aida Aryani Shahrom & Norhayati Hussin, 2018; Meylinda Maria, Faaizah Shahbodin & Naim Che Pee, 2018; Jedaman et al, 2018). The Malaysian education system is also affected by the impact of the IR 4.0 revolution. As a result, the Ministry of Higher Education Malaysia (MoHE) has announced the Malaysia Education Blueprint (MEB) 2015-2025 (MoHE, 2015).

One of the focus stated in the MEB is about effective communication. Effective communication has been a major issue in education and industrial sectors (Accreditation Board for Engineering & Technology [ABET] 2015; 2017; Board of Engineers Malaysia [BEM], 2016; 2019; Ena, Shahrina & Rohani, 2009; Hong Kong Institution of Engineers [HKIE], 2015; Institution of Engineers Singapore [IES], 2018; Institution of Engineers Sri Lanka [IELS], 2014; Lenard & Pintarić, 2018; Pandiyan, 2017). This shows the importance of effective communication. In contrast, poor communication has been the most commonly cited as the cause of disappointment within education sectors and industries particularly in engineering fields (Piyatida Changpeung & Fasawang Pattanapichet, 2015; Ramsey, 2016; Thanky, 2014). In addition, personnel in engineering fields like technicians and engineers are expected to practise effective communication such as in technical communication to convey important information at the workplace (Corneal, 2015). Therefore, engineering students should be

equipped with technical communication skills before they graduate (Corneal, 2015; Hairuzila, Azelin & Mohamed Noor Rosli, 2012; Latisha, Mohammad Fadhili, Mahani & Nazira, 2017; Silyn-Roberts, 1998). Thus, students in engineering education should be able to write technical documents such as manuals and instructions, memos, laboratory reports and analysis, project reports and so forth. The ability to perform well in technical communication could be a bonus to engineering students in securing a job whenever they apply for it. Industries do not only look for graduates who possess technical qualification but also looking for those who can communicate well within the engineering profession.

2. LITERATURE REVIEW

BEM (2016, 2019) has stipulated that engineering education programmes should emphasis on concise reports in both spoken and written communication skills to gain accreditation from the board. This is aligned with the requirement stated at engineering boards at other countries such as in the United State of America, China, Singapore and Sri Lanka (ABET, 2015, 2017; HKIE, 2015; IES, 2018; IELS, 2014). In general, the main purpose of the accreditation boards is to ensure that the engineering programmes offered at the institutions have met the minimum requirements set by the boards. Thus, this study applied the English language as the context in the mode of communication.

According to the requirement from the boards of engineers, engineering students should be able to communicate concisely and specifically. This is implemented when the students are required to complete their report writing tasks. However, according to Siti Hamin and Ismie Roha (2005) in their study at a technical institution in Malaysia on writing proficiency among engineering students, found that engineering students are weak in writing. In another study led by Indra Devi, Noraini and Subatira (2010) discovered that many engineering students fail to perform well in report writing in terms of vocabulary, sentence structure, and grammar. A study at another technical institution on engineering students' views towards writing by Hairuzila (2008) came across three groups of students: (1) students who like and have confidence to write, (2) students who are reluctant to write due to lack of confidence; and (3) students who hate writing because of task difficulty and lack of proficiency in vocabulary and grammar.

In the context of Malaysian polytechnics, a study conducted by Ahmad Esa, Asri, Suhaili and Jaslina, (2014), stated that polytechnic students have contributed many graduates unemployment in Malaysia due to lacking in both spoken and written communication in English. Moreover, the level of communication skill among polytechnic students is only at a moderate level (Ahmad et al., 2014). Besides, in other study conducted earlier has found that polytechnic engineering students were at low to the average level in their English language proficiency (Ahmad Yasruddin et al., 2010; Sanmugam, 2013). Accordingly, it is foreseeable for the students to develop their competence level in English to be marketable and improve the polytechnic graduate employability rate. Also, most of the source of knowledge and information such as the theories and applications in the engineering field are written and taught in the English language. Therefore, students must be competent in both written and spoken English (Joshi, 2013).

A study at a polytechnic has investigated the polytechnic students' perceptions on their language learning experiences revealed that more than fifty per cent of the students corresponded that the English language curriculum did not support them in improving their proficiency in English language (Lam & Chong, 2013). Besides, using correct vocabulary, sentence structure, grammar, and writing technical documents such as writing various types of report are among the skills that polytechnics students lacked (Ahmad Yasruddin et al., 2010, Siti Fazlina, Ramlee & Wan Mazlini, 2018). Conversely, these are the skills needed by the industries (Ahmad Yasruddin et al., 2010; Jobstreet.com, n.d.; Ismail, Ahmad & Awang, 2017). For instance, one of the duties stated in the job advertisements of technician and site supervisor posts is the ability to write a progress report to the manager of an industry (Jobstreet.com, n.d). Hence, problems may occur in the industry if the technician were unable to write a comprehensive report. Therefore, from previous literature, it shows that engineering students have difficulties to practise effective communication especially in writing in terms of vocabulary, sentence structure, and grammar. Furthermore, many debates evolved on poor English language proficiency level of the polytechnic students (Ahmad Yasruddin et al., 2010; Kho & Leong, 2015; Norzila, Fauziah & Parilah, 2007; Salmiza, 2018; Sanmugam, 2013; Suhaili, 2016; Suhaily & Faizah, 2013a, 2013b). For that reason, this study intends to investigate the Communicative English classroom teaching experiences of a mini-project topic among lecturers at Malaysian polytechnics. Apart from that, this study also specifically look into the use of a module in teaching mini-projects.

3. METHODOLOGY

This study utilised a survey design method to collect data. Respondent's retrospective feedback using a set of open-ended questionnaire was employed to identify relevant information on the mini-project teaching classroom experience, the perceptions of the present teaching module used and the needs of module improvement. The

open-ended questionnaire consists of seven items. To make sure the items in the questionnaire are unambiguous and clear, they were pilot-tested by five senior lecturers who were not involved in the study but had 15-25 years of experience in teaching the mini-project topic of the Communicative English course.

Prior to data collection, the researchers were granted permission from the Department of Polytechnic Education Malaysia. The questionnaire was distributed to the respondents by the researchers. Thirteen lecturers from two polytechnics setting volunteered as respondents. The respondents consist of English lecturers with ten to twenty-five years of teaching experiences in polytechnics.

The data gained were analysed using thematic analysis which was adapted from Braun and Clarke (2006). Both inductive and deductive approaches were used to analyse the data. Thematic analysis is used widely for analysing qualitative data. It is suitable to analyse open-ended survey question for both large and small data-sets. It deals with respondents accounts as a source for finding out about their views and experiences (Braun & Clarke, 2006; Taylor & House, 2010). The Braun & Clarke's six-phase framework used for doing a thematic analysis are: (1) step 1: become familiar with the data, (2) step 2: generate initial codes; (3) step 3: search for themes, (4) step 4: review themes; (5) step 5: define themes, and (6) step 6: write-up. Frequency tables were then created from the analysis (Taylor & House, 2010).

4. FINDINGS AND ANALYSIS

Table 1 illustrates the summary of the thematic analysis on lecturers' responses to an open-ended questionnaire regarding students' feelings when presenting and writing a mini-report project in English. The data were analysed using thematic analysis (Braun & Clarke, 2006). The lecturers perceived that the students are feeling burden when presenting findings and writing their mini project in English since they are not familiar with designing questionnaire. In general, the findings show many lecturers remark that their students are not willing to present and write their report in English due to lack of proficiency and confidence when doing presentation and writing in English. The lecturers also perceived that the students are feeling lost when writing the report and they need to be guided.

Table 1: Summary of Thematic Analysis Regarding Students' Feelings in Doing Presentation and Writing a Mini Project Report in English

Theme	Code	Examples	Frequency
Students' feelings when doing presentation and writing in English	Feeling burden	*"No. For them, the mini-project is a burden as it requires them to think and create/design questionnaire which is quite alien for diploma students".*	5
	Feeling hesitate	*"No. Generally no. Students show hesitation when preparing/practicing/delivering on the mini project findings. This is mainly due to their lack of proficiency which led to lack of confidence to conduct an oral presentation".*	4
	Feeling Confuse	*"Yes. In the beginning, students are confused about what it is like.*	2
	Feeling lost	*"When it comes to writing the report, students were quite lost and need to be guided.*	4
	Half enjoy	*"So-so. Students enjoy presenting but not really when it comes to writing reports due to lack of English vocabulary to describe graphs and charts".*	2

The following table (Table 2) indicates the summary of thematic analysis on lecturers' perceptions regarding if the present module of Communicative English course consists of sufficient content to carry out the mini-project topic. As can be seen from Table 2, most of the lecturers perceived that the current module used did not provide sufficient content for the students to carry out the mini-project specifically in basic research knowledge. Furthermore, lecturers also perceived that the module should consist of content related to the engineering field.

Table 2: Summary of Thematic Analysis Regarding the Present Module of Communicative English Course Consists of Sufficient Content to Carry Out the Mini Project

Theme	Code	Examples	Frequency
Module used has sufficient content	Helpful content	*"Yes. In our polytechnic, the team (lecturers who in-charge of the module) would work on the contents and modify/remove the less helpful content. Some examples of the questionnaire are also shown".*	2
	Basic knowledge in doing research	*"No. The mini-project is based on a research project but the content of the module does not provide such information that suitable to polytechnic students".*	10
	Related to the engineering field	*"Not really, even examples are given yet still not enough to facilitate students doing research especially in the content related to engineering field".*	1

Table 3 indicates the summary of thematic analysis on lecturers' perceptions regarding sufficient written exercise for writing a mini-project report. The findings represent most of the lecturers perceived that the present module used did not provide sufficient writing exercise for the students to carry out the mini-project. Lecturers perceived that input in written exercise is not sufficient because the assessment for the mini-project is on presenting the research findings such as explaining the trends and descriptions of graph and charts via an oral presentation.

Table 3: Summary of Thematic Analysis Regarding the Present Module of Communicative English Course Consists of Sufficient Written Exercises to Write the Mini Project Report

Theme	Code	Examples	Frequency
Module used has sufficient written exercise	Examples are given	*"Yes. It should be sufficient because exercises/examples are given".*	2
	Oral presentation	*"No. For Mini Project, students are only assessed on how they report their findings in their oral presentation. Therefore, input on a written report is not included".*	10
	Trends and description of graphs & charts	*"No. Perhaps not so much on writing a report. The focus is mainly on the trends and descriptions of graphs and charts".*	2

	How to write report	*"No. There's not much writing exercise for the report project. More exercise on how to write the report should be added. Lecturers often have to refer to outside sources to enhance students understanding on how to write the mini project report".*	8

Table 4 below shows the summary of thematic analysis on lecturers' perceptions regarding introducing a new module on writing a mini-project in English to polytechnic students. The findings in table 4 indicate that lecturers perceived a new module on writing a mini-project report should be introduced to the students since the content of the present module did not include basic input in the research procedure. The lecturers also perceived that the present module did not provide enough examples of sentences in describing findings of the mini-project. However, there are also lecturers perceived that the polytechnic students need not be introduced a new module on writing a project report since the assessment of the mini-project topic is mainly on the oral presentation.

Table 4: Summary of Thematic Analysis Regarding Introducing a New Module on Writing a Project Report in English to Polytechnic Students.

Theme	Code	Examples	Frequency
The needs of a new module in writing a mini project report	Construct meaningful sentences	*"Yes. Many polytechnic students having difficulties in constructing meaningful sentences. They need good examples of sentences in describing findings of mini-project. This will help them improve their oral presentation when presenting their data".*	3
	Good exposure	*"It might not be as suitable but good exposure."*	3
	Future career	*"It is a useful practice for the technical student to prepare themselves for their future career".*	3
	Basic research	*"The students need to be introduced to basic research information. For example guideline in doing research project".*	2

Table 5 shows the summary of thematic analysis on lecturers' perceptions of areas that they recommend to improve students' writing. The findings show that lecturers perceived the writing areas that students should improve such as sentence structure, presentation skills, grammar, report format, and basic research knowledge to be recommended to improve students' writing. The most area that lecturers perceived to be improved by the students was grammar.

Table 5: Summary of Thematic Analysis Concerning Writing Areas That Students Should Improve

Theme	Code	Examples	Frequency
	Sentence structure	*"I like my students to use correct tense in their writing".*	3
	Presentation skills	*"Students should improve their presentation skills".*	1

Recommended areas for improving students' writing	Grammar	*"Students should know how to use subject-verb agreement (SVA), such knowledge is important so that students can write a meaningful sentence".*	8
	Format	*"With regards to Communicative English 3, I supposed it can be aligned with the reports found in the MUET writing".*	5
	Basic research	*"Students should be taught how to conduct and write a basic research report in English.".*	3

Table 6 presents the summary of thematic analysis regarding lecturers' perceptions on other comments to improve the present Communicative English course and module. The findings reveal that lecturers perceived to discard mini project topic and designing questionnaire since they are not in the syllabus of the Communicative English course. In contrast, there were also lecturers who perceived that to improve the English course or module is by adding important information in basic knowledge in doing research. Other than that, lecturers also perceived to align the content of the English communicative course by referring to MUET writing report format.

Table 6: Summary of thematic analysis regarding lecturers' perceptions on other comments to improve the present module of Communicative English course

Theme	Code	Examples	Frequency
Improvements in the present course /module	Add effective meeting topic	*"Learn to conduct formal meeting".*	1
	Discard unnecessary content	*"Mini project should be scrapped from the module. A designing questionnaire is not in the syllabus. Presentations of their research project findings would be more meaningful".*	2
	Improvise content by adding times on writing skill	*"More emphasize and time can be given for the topic on a resume as writing needs more time and it's a long process to acquire that skill".*	3
	Align content with standard format	*"With regards to Communicative English 3, I supposed it can be aligned with the reports found in the MUET writing".*	2
	Improvise content by adding important information in basic knowledge in doing research	*"The mini-project assignment is related to doing research, thus the course content or module should add related information in doing basic research project such as the process or procedure in doing research".*	3

5. CONCLUSION

Based on the findings of this study, some issues on the implementation of mini-project from teaching experiences were highlighted in the engineering program at Malaysian polytechnics. The findings of the study have shown that lecturers perceived, many engineering students did not enjoy learning the mini-project topic since they were unfamiliar with the task description on doing research, which they have to present the findings in the English language. Furthermore, the findings of this study also revealed that there were perceptions from lecturers to discard the mini-project topic from the syllabus due to the non-existence of designing questionnaire in the syllabus. This showed that the concept of effective communication especially in written communication is hardly practised at the polytechnic education. Thus, based on the findings; the researchers concluded that the

content of the Communicative English course should be improvised. The present module used at polytechnic should also be embedded with specific information on how to carry out a mini project based on basic research so that the students' written outcome would be comprehensive and parallel to the standard report writing used widely. This is to align with the importance of effective communication stated in MEB and BEM as mentioned in the earlier section of this article. Therefore, this study recommended that a new module of mini-research project to be developed inclusively for engineering students at polytechnic to improve their communication skills.

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A STUDY ON RETAIL SERVICE QUALITY (RSQS) AND CUSTOMER LOYALTY IN RETAIL SIMULATION STORE (RSS)

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ABSTRACT

The aim of this study is 1. to analyse the five dimensions of retail service quality (RSQS) and 2. to examine the impact of retail service quality (RSQS) dimensions on customer loyalty. 150 questionnaires were distributed to respondents with the experience in buying products or services at Centre of Excellence (CORE) who were selected using convenience sampling. SPSS version 21 was used to analyse each dimension related to retail service quality and customer loyalty in Retail Simulation Stores (RSS). The findings shows that three dimensions of retail service quality which is physical aspect, personal interaction and policy have significant positive effect on customer loyalty. This study contributes to existing literature by providing indication that retail service quality (RSQS) can influence customer loyalty in Retail Simulation Store (RSS).

KEYWORDS: *service quality, retail service quality, customer loyalty, retail simulation store*

1. INTRODUCTION

The rapid development in technology along with the changes in the retail environment have resulted in a competitive struggle between retailers in the effort to differentiate themselves in terms of characteristics and service to meet the needs of their customers. All retail institutions are required to be more customer-oriented in delivering their products and services to the customers. Excellent service quality along with excellent facilities are among the main factors that can lead to better customer satisfaction during their shopping experience. Customer nowadays becoming more demanding as they have lots of choices as many retail outlet with modern concept is being established. Thus, retailers must always do a research in order to improve themselves in terms of providing products and services. Retention of existing customer is much easier and cheaper comparing than to attracting new potential customer. This show that there is an urge need to build a good relationship with the customer in a long term. The concept of retail service quality (RSQS) has gained a prominent place in the services marketing literature in the last decade. Despite the existence of several researches pertaining to the RSQS of retail stores, limited studies have been conducted in the Malaysian context and at student simulation store. Mesyuarat Pengurusan Jabatan Perdagangan Bil 5/2019 has discuss that management of CORE is not effective and needs to do an improvement in many aspect. Thus, the new management team (lecturer) has been appointed that includes a representative from (DRM, DPR, DPM, DAT) program in Jabatan Perdagangan. Other than that, CORE also were expect to present their sales report each semester in Mesyuarat Jabatan Perdagangan and must allocate some portion of their sales to Jabatan Perdagangan in future. The objectives of this study are (1) to examine the impact of the retail service quality (RSQS) dimensions on customer loyalty, and (2) to analyse the five dimensions of retail service quality (RSQS).

2. LITERATURE REVIEW

2.1 Service Quality

Previous research discussed the definition of service quality from various perspectives, but generally their meaning is just in the same scope. Existing literature has emphasized the importance of service quality to the retail industry (Martinelli & Balboni, 2012). A common measurement scale of service quality is SERVQUAL developed by Parasuraman, Zeithaml, & Berry (1985). It comprises 22 items that are distributed across five dimensions of tangibles, reliability, responsiveness, assurance, and empathy. The SERVQUAL scale has been recognized in various fields including retailing (Wong & Sohal, 2002), higher education institution

(Shekarchizadeh, Rasli, & Hon-That, 2011), automobile (Izogo, 2015), telecommunications (Govender, 2013), and library (Hossain & Ahmed, 2014).

2.2 Retail service quality

Contrary to the use of SERVQUAL in measuring pure service environment, several studies have shown that SERVQUAL is not validated in the retail setting (Mehta, Lalwani, & Han, 2000). Due to the incompatibility of SERVQUAL to be employed in the retailing environment, Dabholkar et al. (1996) has proposed the retail service quality scale (RSQS) as a specific scale to measure the service quality in retail stores environment. RSQS is based on five dimensions which include physical aspect, reliability, personal interaction, problem solving, and policy. The RSQS original scale comprises 28 items where 17 items originate from the existing SERVQUAL scale while the remaining 11 items are derived from the researchers' qualitative work. For this study, several modifications were made in order to suit the items to the retail simulation store (RSS) environment. According to Dabholkar et al., (1996), the retail service quality scale comprises five dimensions as explained in Table 1.

Table 1: Retail Service Quality (RSQS) Dimensions

DIMENSIONS	**DEFINITIONS**
Physical aspect	Appearance and convenience of the retail store.
Reliability	Retailers do the right things and do as they promised.
Personal interaction	Employees are courteous and can inspire confidence in customers.
Problem solving	Employees' ability to handle customer' complaints, returns and exchanges.
Policy	Store policy on parking, operation hours, merchandise quality and credit cards.

Source: Dabholkar et al. (1996)

2.3 Retail Simulation Store (RSS)

The official name of the retail simulation store at Politeknik Sultan Azlan Shah is Center of Retail Excellence (CORE). Its operation began in 2013 as the retail simulation store for the Diploma in Retail Management at the Commerce Department, Politeknik Sultan Azlan Shah (PSAS). This retail simulation store is entirely managed by students as a platform for them to implement their practical knowledge in retail management as learned in the DPR5013: Retail Operation 2 and DPR5023: Retail Buying subjects. The DPR5013 Retail Operation 2 subject provides a practical part of retailing where students are required to conduct practical routine operation in a retail simulation store. The operations include store and merchandise management, promotional strategies and activities, customer services, and retail performance analyses in order to enhance the operational activities in retail stores. Whereas, the DPR5023: Retail Buying subject prepares students with the practical knowledge of purchasing, inventory control, method of pricing, and promotion of merchandise at a retail simulation store. The main foundation of the retail simulation store (RSS) is to encourage work-integrated learning between theoretical knowledge and practical skills.

2.4 Retail Service Quality and Customer loyalty

Nguyen, Nguyen, Cao, & Thu (2017) define customer loyalty in the retail context as "customers' willingness or likelihood to perform favourable behaviours toward retailers or stores, such as repurchase, purchasing more, say positive things about stores, and make recommendation to others." Several studies have explored and validated the relationship between retail service quality (RSQS) and customer loyalty. Nguyen et al., (2017) report that customer loyalty intention is directly related with the dimensions in retail service quality which are reliability, personal interaction, and problem solving. In addition, Sivapalan & Jebarajakirthy (2017) found that to enhance customers' loyalty to retailers, information on the retailers' aspects can be the antecedent for the retail service quality (RSQS) dimensions. This shows that a considerable amount of literature has been published on the retail service quality and customer loyalty. To test the relationship between the variables the following hypotheses were formulated:

H1 – Retail service quality (personal interaction, store policy, physical aspect, reliability and problem solving) has a positive influence on loyalty intentions.

3. METHODOLOGY

3.1 Sample and data collection

The sample of this study comprise of 150 Commerce Department, Politeknik Sultan Azlan Shah students who has an experience buying products or service at the Centre of Retail Excellence (CORE). G-Power software is used to determine the minimum number of sample size. Based of G-Power software, the minimum sample size for this study is 138 respondent. The sample size is according to the effect size (medium 0.15), alpha value of 0.05, beta value of 0.95 and the number of predictors is 5 (which is based on this study variable). Thus, 138 is the general minimum guidelines for data collection, and larger number which is 150 respondent were targeted.

3.2 Development of instrument

The researchers adopted questionnaire method for data collection from their respondents. The questionnaire items was designed based on previous validated scales in the context of retail environment. The questionnaire items for this study were adapted from (Dabholkar et al., 1996) for retail service quality items and customer loyalty items were adapted from (Zeithaml, Berry, & Parasuraman, 1996). However, all the items were modifies accordingly to suit the retail simulation store (RSS) and student context environment. The questionnaire consist of three sections. The Section A consist of the respondents demographic information, Section B consist of questions relating to retail service quality (RSQS) and Section C for customer loyalty questions. Five-point Likert scale ranging from 5 (strongly agree) to 1 (strongly disagree) were used to cater the response of the items in the questionnaire. Data for this study were analyse by using Statistical Package for the Social Sciences (SPSS) version 21. The data also were analyze by using frequency, mean and hypothesis testing.

3.3 Measurement test

Table 2: Reliability Test

Variable	No of items	Cronbach's alpha
Overall Scale	25	.925
Physical Aspects	5	.876
Reliability	4	.862
Personal Interaction	6	.896
Problem Solving	3	.823
Policy	3	.842

Based on the Table 2, all the Cronbach's alpha number were more than 0.7. Thus, it show that all the dimensions are reliable for this study. It includes the overall scale Cronbach's alpha is (0.925), followed by problem solving (0.823), policy (0.842), reliability (0.862), physical aspects (0.876) and lastly personal interaction (0.896).

4. ANALYSIS AND FINDINGS

Table 3 show the demographic profile of the respondents. Based on the table, it shows that (67.3%) of the respondent is female, (78%) of the respondent age range between 18-20 years old, (50%) from Diploma in Retail Management (DRM) course, (79%) are Malay, and (43%) visit CORE more than five times per week.

Table 3: Demographic Profile of the Respondents

Characteristics	Categories	Frequencies	Percentage
Gender	Male	49	32.7
	Female	101	67.3
Age	18-20	117	78
	20-22	30	20
	22-24	3	2
Course	DAT	5	3.3
	DPM	65	43
	DPR	4	2.6
	DRM	75	50
Race	Chinese	3	2
	Indian	27	18
	Malay	118	79

	Others	2	1
Number of visiting CORE per week	Once	11	7.3
	Twice	26	17
	Third	25	16.6
	Four	10	7
	Five	13	9
	More than five	65	43

4.1 Dimensions of retail service quality

Table 4 shows the mean values and standard deviations of retail service quality and customer loyalty dimensions. The mean values for this study falls in the range of (3.5 - 3.8) which show a high level of retail service quality and customer loyalty dimensions. The highest mean score is physical aspect with (3.8), while the lowest mean score for this study is problem solving with (3.5). Oxford (1990) stated that mean score between (3.5 – 5) interpreted as high, mean score (2.5-3.49) interpreted as medium and mean score (1.0 – 2.49) interpreted as low.

Table 4: Mean Values and Standard Deviations

Variable	Mean	Std. Deviation
Physical aspect	3.800	0.735
Reliability	3.533	0.824
Personal interaction	3.548	0.843
Problem solving	3.502	0.877
Policy	3.668	0.838
Customer Loyalty	3.797	0.800

4.2 The impact of retail service quality dimensions on customer loyalty

A multiple regression analysis is conducted to test the relationship of retail service quality (physical aspect, reliability, personal interaction, problem solving and policy) and customer loyalty. Multiple linear regression is chosen for this study because there are more than one independent variable in the research model. This study finds that all the five dimensions in retail service quality explained 67% ($R^2 = 0.658$) of the variation in customer loyalty. As overall the model is good fit (p-value = .000).

Table 5: Summary of Regression Model

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.819[a]	0.67	0.658	0.46771

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	.502	.216		2.329	.021
	Physical aspect	.130	.073	.119	1.767	.079
	Reliability	.061	.080	.061	.754	.452
	Personal interaction	.279	.083	.292	3.350	.001
	Problem solving	.075	.071	.082	1.056	.293
	Policy	.361	.076	.375	4.740	.000

Table 5 shows that three dimension of retail service quality (policy, personal interaction and physical aspect,) had a significant influence on customers' loyalty, while the impact of another two dimensions (reliability and

problem solving) was not significant. In addition, policy dimensions shows the strongest impact on customer loyalty (β =0.375), followed by personal interaction (β =0.292) and physical aspect (β =0.119). This finding is opposite with Nguyen et al., (2017) findings which is reliability, personal interaction and problem solving is significant while policy and physical aspect is not significant towards customer loyalty. This difference is probably because of the difference environment settings in terms of respondent and culture. However, generally this study is in line with (Prakash, Somasundaram, & Krishnamoorthy, 2018) which is reliability and problem solving is not significantly influence loyalty. Sivapalan & Jebarajakirthy (2017) also supports that physical aspect and policy significantly affect customer loyalty.

5. LIMITATION

Unlike most previous studies that apply RSQS in the retail store context, the result being reported in this study may differ as it is conducted in the context of retail simulation store. Furthermore, this study apply RSQS to Centre of Retail Excellence (CORE) at Politeknik Sultan Azlan Shah only. Therefore, the findings may be different if it is implemented at other retail simulation stores. In addition, as the sample size of this study is limited to 150 respondents, the results being reported in this paper may not represent the general population, should be treated with cautious, and its accuracy can be further improved with a bigger number of respondents.

6. CONCLUSION

The result of this research indicate that the RSQS models are appropriate for measuring retail service quality in the context of retail simulation store in Politeknik Sultan Azlan Shah this is because the overall Cronbach's Alpha is (0.925) which is more than 0.7. This shows that all the dimensions area reliable for this research.

The first objective of this study is to analyse the five dimensions of retail service quality (RSQS), thus based on the mean score for the overall dimensions, all the dimensions interpreted as high mean score as it in the range of (3.5 - 3.8). Based on this study CORE should improve their problem solving aspect with the customer as this dimensions score the lowest with 3.5 score. CORE can do survey, distribute manual or online feedback form, train their staff especially semester 1 students in dealing with any problem that will arise in order to improve their problem solving aspect. Second objective is to examine the impact of retail service quality (RSQS) dimensions on customer loyalty, thus based on the regression model for this study three dimension of retail service quality (policy, physical aspect and personal interaction) had a significant influence on customers loyalty, while the impact of another two dimensions (reliability and problem solving) was not significant. As policy dimensions is the strongest influence to customer loyalty, CORE should maintain and continuously improve their quality of merchandise and ensure their operations hour is convenient to their customer. Other than that, in order to improve reliability and problem solving dimensions, it is suggested CORE ensure their sales transaction is error free and train their staff especially semester 1 students in dealing with any problem that will arise in order to improve their problem solving aspect.

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GENE TRANSFER BETWEEN ANTIBIOTIC-RESISTANT E. COLI AND NON-ANTIBIOTIC-RESISTANT BACTERIA IN WATER ENVIRONMENT

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ABSTRACT

Gene transfer processes are the conditions where bacteria can transfer their genes to other bacteria. When a process occurs where one cell acts as a donor and the other cell acts as a recipient, it is called genetic transfer. E.coli genome is one of the large circular DNA molecules where it allows a copy of replicating F (fertility factor) to enter the partner cell during conjugation. This study was conducted to demonstrate the possibility of gene transfer process among ARBs and non-ARBs in environmental condition. E. coli is not only relatively slow in terms of receiving the gene from other isolates, but also slow in donating gene that is accepted by other isolates. This can be demonstrated from 50 isolates, only 3±1.41 of Shigella spp. was positive to chloramphenicol, 7±2.12 positive to ampicillin, and 11±0.0 positive to trimethoprim-sulfamethoxazole. Meanwhile, Salmonella spp. isolates were positive for chloramphenicol, ampicillin, and trimethoprim-sulfamethoxazole with 5±0.71, 7±0.71, and 8±1.41, respectively. Bacteria can be survived and multiply easily grown in the lab environment, when it has enough nutrients either in solid agar in petri dish or in a test tube containing an aqueous media. It can be concluded that the E. coli containing antibiotic-resistant gene could transfer their resistant gene to another non-antibiotic-resistant gene in wastewater, and wastewater treatment plants are hotspots for horizontal transfer where bacteria allow the spread of resistant gene between different bacterial species.

KEYWORDS: *gene transfer; antibiotic resistant; water environment*

1.0 INTRODUCTION

Gene transfer processes are the conditions where bacteria can transfer their genes to other bacteria. There are several ways in which a gene is transmitted to other bacteria, such as through transduction, transformation, and conjugation. Gene transfer methods are as shown in Table 1.

Table 1: Gene Transfer Methods

Ways of gene transfer	Process
Transduction	a bacterial phage (virus) picks up a piece of DNA from one bacterial cell and injects it into another where it is incorporated into the chromosome.
Transformation	A bacterial cell picks up a piece of DNA from its environment and incorporates it into its chromosome or DNA taken up is a plasmid that is able to replicate in the host bacterium.
Conjugation	One bacteria transfers DNA to another bacteria.

Sources : Mordacq and Ellington (1998).

When a process occurs where one cell acts as a donor and the other cell acts as a recipient, it is called genetic transfer. *E. coli* genome is one of the large circular DNA molecules where it allows a copy of replicating F (fertility factor) to enter the recipient cell during conjugation (Arber, 2014; Phornphisutthimas et al.,2007). The conjugation process in this bacteria can be visualized through two mechanisms namely 'shoot and pump' where DNA is shoot into the recipients through the membrane and the process continuing with where DNA is injected into the recipient cell by multiplying the protein (Llosa et al., 2002). Antibiotic-resistance in bacteria is transferred from the multi-drugs *E. coli* to the inoculated strain *Salmonella*, where this tested strain demonstrates resistance to more than one antibiotics (Edrington, et. al., 2013). However, in medical studies, this is not new. The transfer of this resistant gene has actually been detected as early as the 80s where transfusion of bacterial resistance against trimethoprim and gentamicin occurred in the general hospital around London. The hospital is where numerous harmful bacteria

can be found and where infection or transplantation can spread rapidly. Therefore, this study will investigate the potential of antibiotic-resistant gene to transfer from domestic wastewater to wastewater treatment plant.

Gene cannot only be transmitted to the same species of bacteria, but can also be transferred to different species of bacteria (Winokur et al., 2001). In the wastewater treatment plant there are many different bacterial species that are feared to transfer the resistant gene to non-resistant bacteria. Therefore, this study will investigate the potential of antibiotic-resistant gene to transfer from domestic wastewater to wastewater treatment plant and the effluent.

2.0 METHODOLOGY

To maintain the continuity of life, the ability to evolve with the changing of genetic material between two cells is very important. Genetic recombination in bacteria can occur through transformation, transduction, and conjugation. This experiment was conducted to demonstrate the possibility of gene transfer process among non-ARBs and ARBs in environmental condition.

2.1 Stock Preparation

Indigenous multi-drugs resistant (MDR) bacteria of E. coli was cultured directly from the susceptibility test done previously, where the source of wastewater was from the wastewater treatment plant. Salmonella typhi ATCC 14028 and Shigella sonnei ATCC 25931, were purchased from Thermo Fisher Scientific and used as the recipient cells. All agar media were obtained from Oxoid (UK) unless otherwise stated.

2.2 Procedure for Gene Transfer

All the bacteria purchased from Oxoid were tested for susceptibility to confirm the bacteria were antibiotic-resistance free. The method for gene transfer was modified from Bearson and Brundle (2015) and Phornphisutthimas (2007). The procedure for gene transfer is shown in

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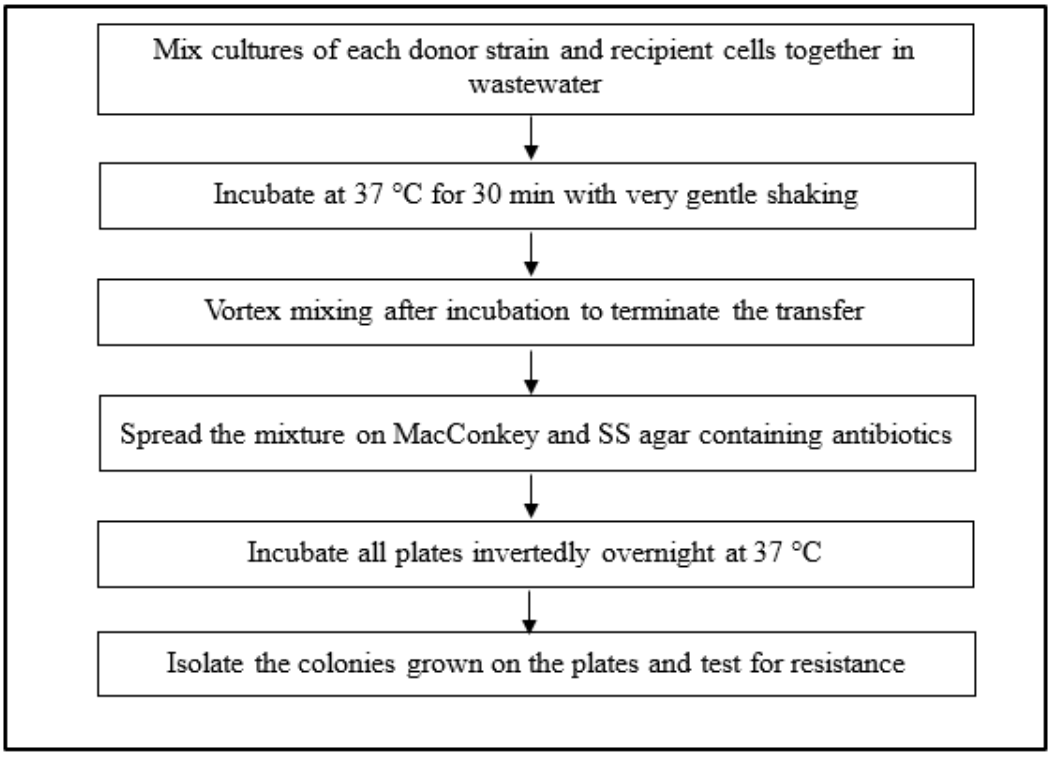

Figure 1: Procedures for Gene Transfer

Ten overnight cultures of donor strain (MDR *E. coli*) and 100 recipient cells were mixed together in wastewater. The mixtures were incubated at 37 °C for 30 min with very gentle shaking, with a very brief vortex mixing after incubation to terminate the transfer, and then spread on MacConkey and SS agar containing ampicillin (10 µg/ml), chloramphenicol (10 µg/ml), and trimethoprim (2 µg/ml). All plates were incubated inverted overnight at 37 °C. A total of 100 (50 colonies for each recipient) colonies grown on the plates randomly isolated and tested for resistant following the Kirby-Bauer method.

3.0 RESULTS AND DISCUSSION

Resistance transfer between bacteria in several conditions and environments has been reported previously (Lee, 2019; Edrington et. al., 2013; Yang, 2013; Okatomo et. al., 2009; Datta et. al., 1980). Table 2 shows the results of gene transfer for MDR-E. coli. The gene transfer test was done using autoclavable secondary effluent wastewater.

Table 1: Positive Sample for Gene Transfer

MDR	Recipient	Sample	Number (+)ve sample					
			Ch	Sd	Amp	Sd	Tmp-Smx	Sd
E. coli	*Shigella spp.*	50	3	±1.41	7	±2.12	11	±0.00
	Salmonella	50	5	±0.71	7	±0.71	8	±1.41

Fifty random isolates for each test sample were taken for gene transfer testing. *E. coli* is not only relatively slow in terms of receiving the gene from other isolates, but also slow in donating gene that is accepted by other isolates. This can be demonstrated when only 3±1.41 of *Shigella spp.* was positive to chloramphenicol, 7±2.12 positive to ampicillin, and 11±0.0 positive to trimethoprim-sulfamethoxazole. Meanwhile, *Salmonella spp.* isolates were positive for chloramphenicol, ampicillin, and trimethoprim-sulfamethoxazole with 5±0.71, 7±0.71, and 8±1.41, respectively. Bacteria can be survived and multiply easily grown in the lab environment, when it has enough nutrients either in solid agar in petri dish or in a test tube containing an aqueous media.

It can be concluded that the bacteria containing antibiotic-resistant gene could transfer their resistant gene to another non-antibiotic-resistant gene in wastewater. Several reports have shown that wastewater treatment plants are hotspots for horizontal transfer where bacteria allow the spread of resistant gene between different bacterial species (Igwaran et. al., 2018; Karkman et. al., 2018; Ojala, et. al., 2014). Bacterial conjugation is one of the horizontal transfer process where a two-step mechanism for DNA transport (Li, et. al., 2019; Llosa et. al., 2002). This process allows resistant bacteria to shoot the DNA into non-resistant bacteria and then a bulk of DNA is injected into recipient wall. The conjugation process could occurred either between same species or different species of bacteria (Jiao et.al., 2017).

To survive in the wastewater system, bacteria need minimal medium containing their essential nutrients such as a carbon source (normally glucose), water, and inorganic salts (Yang et. al., 2013; Mordacq and Ellington, 1998). The gene transfer will contribute to higher rate of resistance among bacteria during treatment process in a wastewater treatment plant and lead to more genetic transfer after being discharged into water bodies if the environment could not control the minimal nutrients that support the transfer process.

4.0 CONCLUSION

Overall, when humans are exposed to high concentration level of the bacteria antibiotic-resistant, their health is adversely affected. ARB detected in the secondary effluent are easily detached and thus free to enter water bodies in the vicinity of the WWTP. Gene transfer tests showed that the resistant gene can be transferred to a gene that is initially not resistant. This is a bad sign and the situation could grow worse if the transfer of resistant gene is not controlled. Therefore, the risk to human health should be taken into account and examined to get an idea of how humans are affected when exposed to an increased risk of antibiotic-resistant bacteria through skin contact.

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THE PERFORMANCE OF TAKAKURA COMPOSTING USING FOOD WASTE FROM MAKANAN RINGAN MAS INDUSTRY

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ABSTRACT

Composting food waste is an alternative method to recycle the waste to become nutrient enriched soil amendment, generating less leachate and reduce gas emissions. The aim of this study was to investigate the performance of backyard composting method by utilizing waste generated by Makanan Ringan Mas Industry (MRMi). Two types of backyard composting (research compost and commercial compost) were prepared with different decomposing medium and fermentation liquids. There are four reactors for research compost and four reactors for commercial compost including control and mixed with different types of food waste collected. Then each reactor was matured up to 22 weeks and final nutrient content was determined to evaluate their level of decomposition. Physical and chemical parameter were conducted to observe the effectiveness of each reactor. As for physical parameters, maximum 44 °C was observed in Reactor B1 and Reactor B2. As for chemical parameters, only Reactor B1, Reactor B2, Reactor D1 and Reactor D2 shown good values. After 22 days of maturation, Reactor B1 and Reactor B2 were will decomposed and obtained value of TKNPK with 0.63 %, 10.57 ppm, 726.07 ppm and 0.84 %, 15.45 ppm and 727.81 ppm respectively. While Reactor C1 determined the lowest decompose compost maturation with lower TKNPK (0.49 %, 11.19 ppm, 622.56 ppm) and C:N ratio value 46.26. Nevertheless, all the results obtain indicate that all the composted food waste with the suggested decomposing medium and fermentation liquid are suitable and adequate to be used as soil amendment and as an organic compost.

KEYWORD: *composting, food waste, fermentation liquid, banana peel*

1. INTRODUCTION

Landfilling of mixed wastes is the worst solution as the degradation process can lead to harmful gas emissions and leachates (Abdul Hamid *et al.*, 2012; Masirin *et al.*, 2008). Another option for MSW is incineration. Although this method has become popular nowadays because it can reduce the amount of waste for sanitary landfilling, it produce harmful gases, particles, and ash (Chua *et al.*, 2011). According to Masirin *et al.*, (2008), the incineration process can reduce the volume of waste by about 90%, it incurs high operational costs and but the resulting ash contains high levels of heavy metals. In addition, the high moisture and organic content in MSW contribute to the failure of the incineration process (Ismail & Manaf, 2013). Thus, the best method to manage food waste efficiently, according to Dhokhikah and Trihadiningrum (2012), is by composting solid waste. This method is more suitable for treating organic waste in developing countries.

Composting is also a sustainable alternative for managing and recycling organic solid waste because it can produce compost which can be useful for agriculture (Pagans *et al.*, 2006). By composting, the amount of greenhouse gas emissions formed from decomposing organic material in landfills decreases (Mustapha, 2013, Chien, 2012). According to Masirin *et al.*, (2008), composting solid waste can significantly reduce solid waste volume, especially in countries where organic waste and yard waste are predominant. In addition, Saheri *et al.*, (2009) contended that composting organic material that has been diverted from landfills prevents the production of methane and leachates in landfills, increases the lifespan of landfills, and reduces land use. Thus, composting is considered the best alternative method for food waste disposal as it is environmentally safe, cost effective and hygienic.

Nevertheless, the composting medium and fermentation liquid can affect the degradation process of food waste. Composting is a natural process that generates heat and moisture which allow food waste to decompose. The availability and sustainability of the composting medium and fermentation liquid are important to ensure an effective composting process. Thus, in this research, available food waste will be composted using feasible, sustainable and economical composting mediums and fermentation liquids that are locally available.

Therefore, this study focuses on food waste production by small and medium industries around Parit Raja, Batu Pahat, Johor, as the amount of food waste produced is extremely high. In general, this industry operates 24 hours

a day as the production depends on customer needs. Makanan Ringan Mas Industry (MRMi) at Parit Kuari Darat is one of the medium scale industries that focuses on food production. The food waste produced by MRMi includes grated coconut, tamarind husks, banana peel and tapioca peel. Improper waste management such as open dumping and open burning has been practised in this industry.

2.0 MATERIALS AND METHOD

2.1 Collection, Composition, and Classification of Food Waste

The waste was collected weekly in order to obtain data on waste generation, waste composition, and classification. The waste was collected from MRMi by car for 12 months. Food waste collected was placed into a plastic bag for processed food waste while a gunny bag was used for raw food waste. Every weekend, the plastic bags and gunny bags were collected and weighed. All the waste was unloaded at the Micropollutant Research Centre (MPRC), UTHM lab and recorded.

2.2 Preparation of the starch fruit (banana peel) fermentation liquid

The fermentation liquid was prepared according to the procedures used in the study by Mat Saad et al., (2014). There are two types of fermentation liquid namely, banana peel solution and fermented soybean solution. The banana peel solution is a research fermentation liquid while the fermented soybeans solution is the commercial fermentation liquid. . During the fermentation process, the bottle caps were opened once a day to remove the gas trapped inside the bottle. The fermentation solution was left for 5 days to allow the fermenting microbes to grow before being mixed with the decomposing medium.

Therefore, according to Swain *et al.,* (2014), this fermenting solution can be obtained from fresh fruits, vegetable peel, coconut wine and brown sugar. In order to fully utilize the food waste generated at Makanan Ringan Mas, the preparation for fermentation liquid is by using banana peel as research fermentation liquid.

Three liters of water, 250 grams of salt and 250 grams of banana peel were the ingredients used for the salt solution. The banana peel was cut into small cubes and placed in closed bottles. The mixture of water, salt, and banana peel was shaken to ensure that all the salt dissolved evenly. While, for commercial fermentation liquid Three liters of water, 250 grams of brown sugar and fermented soybeans were the ingredients used to make the sugar solution. The fermented soybeans were cut into small cubes and placed in closed bottles. The mixture of water, brown sugar and fermented soybeans was shaken to make sure that the brown sugar completely dissolved.

2.3 Preparation of composting medium

8 compost reactors which consisted of 4 research compost reactors and 4 commercial compost reactors were used in this study. A basket was used as the container in this study. A carpet was placed around the basket to avoid external disturbance. 3 kg of soil and the decomposing medium were placed in each basket. After the preparation of the compost (research and commercial compost), the food waste generated by MRMi was placed in the reactors as shown in Table 1.

Table 1: Reactors with Different Types of Food Waste

Reactor	Classification food waste	Types of food waste
A1, A2	Control	-
B1, B2	Processed food waste	Candy + chips
C1, C2	Raw food waste	Banana peel + tapioca peel + coconut husk
D1, D2	Processed food waste + Raw food waste	Candy + chips + tapioca peel + banana peel + coconut husk

2.4 Parameter Measurement

Backyard composting was conducted using eight reactors consisting of four research composts and four commercial composts. The research compost utilized soil with coconut fibre as the decomposing medium along with banana peel as the fermentation liquid, while the commercial compost used soil and rice husk as the decomposing medium along with fermented soybeans as the fermentation liquid. For each set of reactors used, one reactor acted as the control while the other three were placed with food waste. The compost was tested in

terms of physical and chemical parameters. The compost samples were analysed according to the standard methods

3.0 RESULTS AND DISCUSSIONS

3.1 Waste Generation Rate

The MRMi waste composition (in kg) of general waste can be divided into 6 categories. It was revealed that food waste (chips, coconut candy, banana peels, tapioca peels, coconut husk and breadfruit peels) accounted for the largest proportion of waste generation by MRMi. The food waste can be classified as processed food waste and unprocessed food waste. It can be observed that banana peel was the largest waste category, representing approximately 26.42% of the total amount of food waste generated. This is followed by tapioca peel, grated coconut and chips at 24.79%, 16.59% and 14.38%, respectively. The percentages of breadfruit peel and coconut candy were less than 10%. Banana peels formed the highest waste composition (301.87 kg), followed by tapioca peel, chips, coconut candy, coconut husk and breadfruit peels. The highest amount of raw food waste generated by MRMi was fruit peel. The main production of this industry is food, of which a variety of chips are produced. Hence, the amount of fruit peel generated was quite high. This is supported by previous studies that reported that fruit waste, which is highly perishable, is a problem for the processing industry (Chikku, 2014; Madhav & Pushpalatha, 2002).

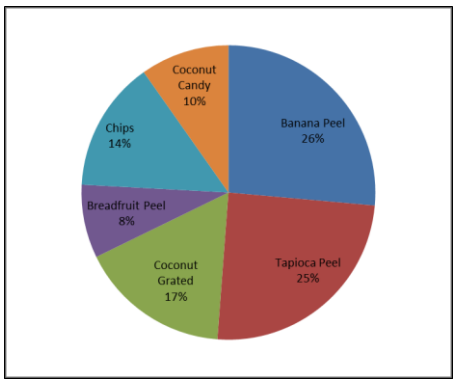

Figure 1: Composition (%) of the Amount of Food Waste Generated by the Makanan Ringan Mas Industry (MRMi)

3.2 Physical Parameter -Temperature

In this study, the changes in temperature are due to the different food wastes placed in the reactor. This is supported by Pagans *et al.*, (2006) who found a combination of organic compounds that contain protein, fats, and a large amount of organic nitrogen which are easily degradable.

From the results, processed food waste (Reactor B1 and B2) and the combination of processed and raw food waste (Reactor D1 and D2) have been found to be the ideal combination of food waste as the compost temperature recorded a temperature rise up to 40 ºC and 44 ºC. During the composting process, heat is important as it promotes microbial activity which helps degrade organic matter (Luangwilai *et al.*, 2011, Hassen *et al.*, 2001). According to Venglovsky *et al.*, (2005), the maximum microbial activity during the composting process takes place at temperatures between 35 ºC and 40 ºC. Meanwhile, Boulter *et al.*, (2000) at temperatures between 40 ºC to 45 ºC, the presence of weed seeds and pathogens in the compost are killed.

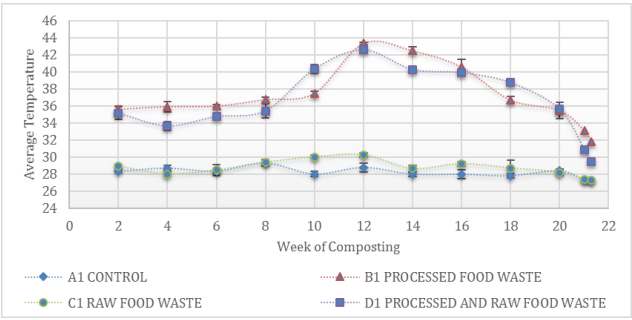

Figure 2: Changes in Temperature in the Research Compost

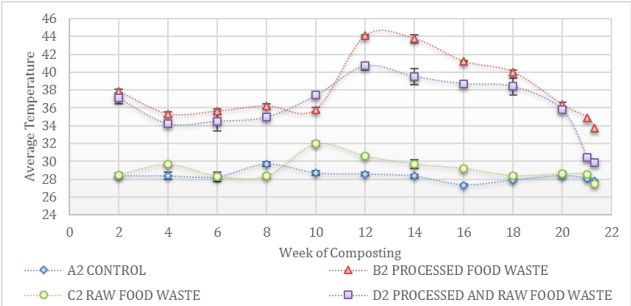

Figure 3: Changes in temperature in the commercial compost

3.3 Chemical Parameter -Total Kjedahl Nitrogen

In this study, the concentration of total kjedahl nitrogen (TKN) for both composts gradually increased at the end of the composting process The initial value of TKN in the early stages of composting was 140 ppm for the research compost and 168 ppm for the commercial compost in Reactor B1 and Rector B2 (processed food waste). At the end of the composting process, both compost reactors showed an increase in TKN content which was 2269 ppm and 2268 ppm respectively. In contrast, for the reactor containing processed food and raw food waste, the initial TKN concentration recorded was 112 ppm for Reactor D1 and 182 ppm for Reactor D2. However, the TKN concentration increase in week 20 to 2240 ppm and 2072 ppm for Reactor D1 and D2, respectively. This was similar to the TKN concentration for Reactor C1 and Reactor C2 which contained raw food waste. Thus, the type of food waste in each reactor influences the TKN concentration value due to the loss of total organic carbon as carbon dioxide (CO_2) during the composting process. This is supported by Shymala and Belagali (2012) who found that the increase in nitrogen concentration during composting was possibly due to the degradation of organic carbon that reduces the weight of the composting materials

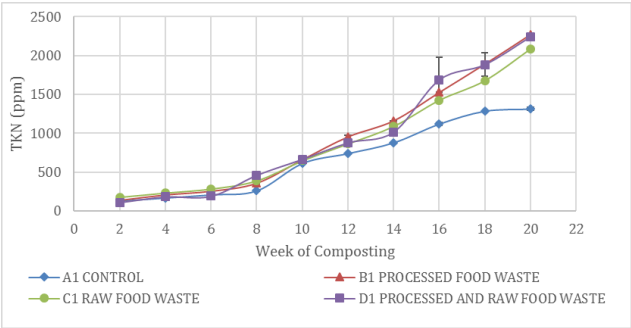

Figure 4: TKN Values for Research Compost

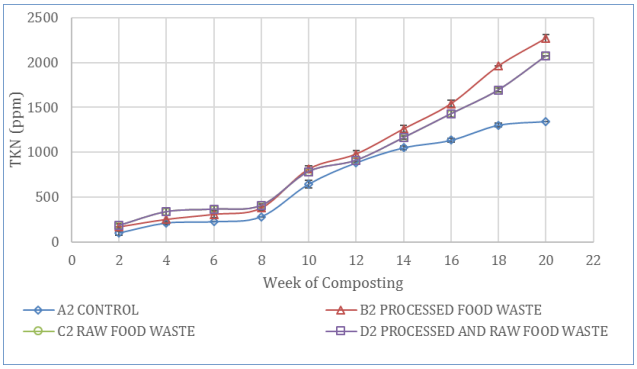

Figure 5: TKN Values for Commercial Compost

3.4 Phosphorus (P) Concentration

Phosphorus (P) content increased as decomposition progressed for research compost and commercial compost. The P value in the research compost ranged from 2.198 ppm to 9.973 ppm for Reactor B1 (processed food waste), 1.968 ppm to 9.251 ppm for Reactor C1 (raw food waste) and 3.308 ppm to 11.418 ppm for Reactor D1

(processed and raw food waste). For the commercial compost, the P concentration ranged between 1.860 to 10.352 ppm for Reactor B2 (processed food waste), 1.062 ppm to 11.451 ppm for Reactor C2 (raw food waste) and 2.047 ppm and 11.616 ppm for Reactor D2 (processed and raw food waste). The highest P concentration was recorded by the reactor containing processed and raw food waste for both types of compost namely, 11.418 ppm for Reactor D1 and 11.62 ppm for Reactor D2.

The difference in the concentration of P may be due to the type of food waste that is able to enhance the mineralization of organic matter under composting conditions. Therefore, from the results obtained, a high amount of P was obtained by reactors containing both processed and raw food waste (Reactor D1, D2). On the other hand, the lowest P content of 9.257 ppm was recorded in Reactor C1 which consisted of raw food waste. This was due to the leaching and slow decomposition processes. This is supported by Chaudhry *et al.* (2013) who stated that the lowest P content could be attributed to the leaching of mineralized P by excessive water from the heap and slow decomposition in the reactor. Furthermore, according to Shymala and Belagali (2012) and Janakiram and Sridevi (2010), the increase in P might be due to the decrease in water solubility due to humification. Hence, phosphorus solubility during decomposition was subjected to a further immobilization factor. From the results, Reactors D1 and D2 produced compost with higher values of P compared to Reactors B1, B2, C1 and C2.

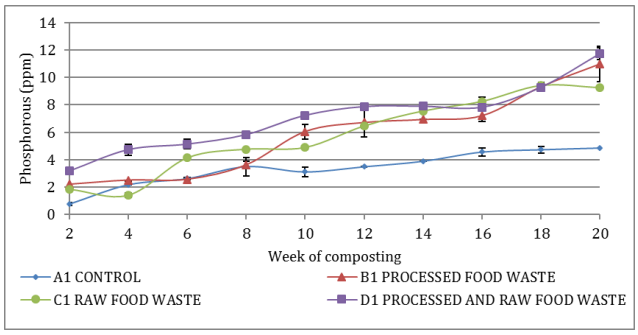

Figure 6: Phosphorus Values of the Research Compost

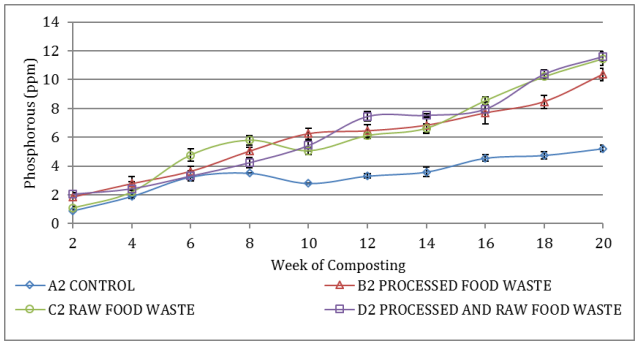

Figure 7: Phosphorus Values of the Commercial Compost

3.5 Potassium (K) concentration

Potassium (K) concentration in both composts increased with composting time under aerobic conditions. The K concentration for the research compost was found to be between 127.75 ppm to 666.95 ppm for Reactor B1 (processed food waste), 105 ppm to 582.21 ppm for Reactor C1 (raw food waste) and 119.73 ppm to 606.65 ppm for Reactor D1 (processed and raw food waste). On the other hand, the K concentration for the commercial compost ranged from 130.15 ppm to 633.40 ppm for Reactor B2 (processed food waste), 210.02 ppm to 516.00 ppm for Reactor C2 (raw food waste) and 243.70 ppm to 645.55 ppm for Reactor D2 (processed and raw food waste). This result showed a less significant difference in K concentration. The K content was higher at the end of the decomposition period for reactor B1 (666.95 ppm for the research compost) and Reactor D2 (645.55 ppm for the commercial compost).

The influencing factor that contributed to the increase in potassium value is the decomposing medium used. Coconut fibre and rice husks can absorb and maintain moisture content as the degradation of organic matter is enhanced by the activity of microorganisms. This has been reported by several researchers. According to Shymala and Belagali (2012), and Jusoh *et al.*, (2013), the decomposing medium influences the increase in K due to characteristics that allow the absorption of moisture content as well as the maintenance of structural integrity and porosity. On the other hand, Haiba *et al.*, (2014) found that microbial activity enhances the availability of K. Nevertheless, according to Frank (2013), the K concentration may be affected by the higher

rate of carbon loss when organic matter is decomposed or mineralised into CH_4 (methane) or CO_2. In general, no significant values were recorded for both research compost and commercial compost. However, Reactor B1 was observed to have achieved the highest K value of 666.95 ppm.

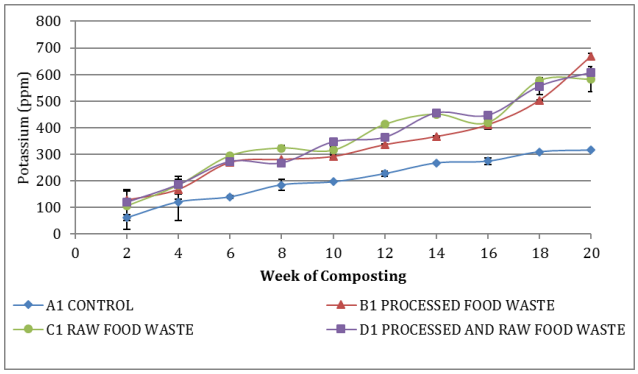

Figure 8: Potassium Values for Research Compost

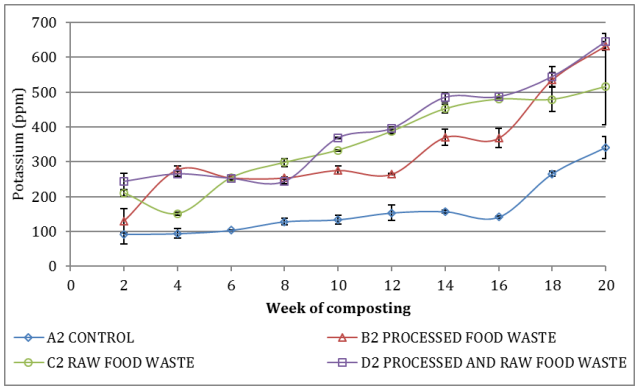

Figure 9: Potassium Values for Commercial Compost

4. CONCLSUSION

It was discovered that food waste accounted for the largest proportion by MRMi. The increase in waste generation rate by MRMi in every month due to people are demanding more food especially on festival, school holidays and seasons. The lack of pre-treatment and specific treatment facilities uncontrolled disposal for this industry. Moreover, the results showed that the average generation of food waste at MRMi was 101.82 kg/month. MRMi. Results from the analysis indicated that the 70% of raw food waste is generated by this industry while 24% is processed food waste. Based on abundance of food waste produced, composting was suggested as an alternative means of waste management.

As for the physical parameters all the parameters measured indicate that the decomposition process occurred in both composts. Physical parameters such as temperature showed that the decomposition of food waste occurred during the composting period of 20 weeks. It indicated that the temperature recorded reached the proposed thermophilic range (>40 °C) in which the temperature recorded was 44 °C. As for the chemical analysis, the highest TKN concentration of 8400 ppm was recorded by Reactor B2 which consisted of processed food waste. A low amount of P at the beginning of composting process was observed but the value started to increase with time during the decomposition process. The highest available P of 17.40 ppm was recorded by Reactor D1 (research compost). On the other hand, the highest K concentration of 727.81ppm was recorded by Reactor B2 (commercial compost) that consisted of processed food waste. A C:TKN ratio of 21:1 was achieved by Reactor B1 while a C:N ratio of 22:1 was achieved by Reactor B2 (recommended range 20-25).

Thus, the degradation of food waste occurs during the composting period. The presence of bacteria colonies was found to be more prominent in reactors containing processed food waste compared to reactors containing raw food waste. This shows that the reactor containing processed food waste was active.

This study shows that research compost B1 which consists of chips and coconut candy represents the best takakura composting composition as it yielded 6300 ppm, 10.57 ppm and 726.07 ppm of TKN, P and K, respectively. Meanwhile, commercial compost B2 yielded 8400 ppm, 15.45 ppm and 727.81 ppm of TKN, P and K, respectively. A slight difference value was demonstrated between research compost and commercial compost. In addition, both research compost and commercial compost recorded low concentrations of cadmium, chromium copper, lead, nickel, zinc, and arsenic. Thus, objective 3 was also achieved. To conclude, overall the

research compost is comparable to the commercial compost. In addition, the compost prepared was found to be the stable product prepared and acceptable as compost fertilizer for native plantings. As a conclusion, that this composting method can be used as alternative food waste management by Makanan Ringan Mas Industry (MRMi).

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