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Controller Optimization Evaporation Process of Salt Solution in Green House using Fuzzy Logic Controller

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A B S T R A C T

Salt processing commonly conducted by using heat energy from solar. Process begins with heating salt water from sea on the embankment with a period approximately 30 to 40 days. In the rainy season the quantity of salt produced decreases due to weather. Some salt farmers prefer not to produce in the rainy season because it's a high risk percentage. The aim from this research is to help them, we create greenhouse technology that can optimize the process of evaporation of old salt water into salt. This technology allows salt farmers to produce salt without regard to the influence of the weather, both dry and rainy seasons. This technology maintains indoor temperatures according to the best temperature of the evaporation process using heating elements. Technology in the form of a greenhouse with a prism-shaped roof. If the temperature in the room exceeds the optimal temperature, then the heat in the room will be released through the exhaust air until the temperature becomes optimal again. This system uses the Fuzzy Logic Control method to regulate temperature, humidity and air pressure.

Keywords: Green house, salt, evaporaion, temperature, humudity, air Pressure, Fuzzy Logic Controller

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1. Introduction

One of strategic commodities in the national scale is the salt [1]. Indonesia is a salt-producing country to supply national salt demands. The salt produced are consumption and industrial salt. They produce the salt from local people salt [1]. The stages of making salt produced by people start from taking and collecting seawater, aging of seawater, crystallization of seawater and the last steps is harvesting and salt compaction [2].

Almost salt farmers using solar energy as evaporating salt water. This condition caused by the tropical climate that occurs in Indonesia [2,3]. Therefore, it can say that climate is the most influential factor on the salt production because as an energy source that affects the rate of evaporation of sea water in salt embankment. Producing salt conducted by taking salt in sea water with the natural evaporation method with sunlight. Process begin from handling sea water intake until harvesting salt takes approximately 30-40 days [2]. During the rainy season with erratic weather, i.e. rainfall falls throughout the year causing salt production to decrease dramatically. This is a significant cause and inhibitor for the income of salt farmers.

Another problem that occurs in process salt are the quality of people salt on average with percentage 85% NaCl [3]. This happens because the techniques and tools used in processing salt are traditional and not applying technology to improve the quality of salt [4]. While salt quality must be meet percentage over 94% NaCl. Meanwhile, increasing import salt make local salt price become depression, beside their quality. This condition impacts to the welfare of salt farmers [5].

Some factors that influencing evaporation process such as temperature, humidity, pressure and the rate of evaporation. When temperature increasing temperature because continuous heat from sun and the lower pressure [6]. Besides the temperature and pressure the rate of evaporation influenced by the water content on solution where the lower the water content, the solution becomes more concentrated so that the rate of evaporation decreases because steam is more difficult to form. Other factors that influence rate of evaporation are surface area, evaporation duration, and material conductivity [7]

A research conducted on the prism-shaped greenhouse effect has the aim of temperature distribution has a relative homogeny with a room temperature about 45°C - 60°C at average temperature 53°C as a heat storage room. The stored heat is 40 ° C with a range of room temperatures from 30°C to 37°C. A rectangular prism greenhouse with stone variations as a heat storage has a faster drying efficiency [8,9].

Salt water evaporation process by using sunlight have a tendency wasting time [10]. Therefore, in this research we made a greenhouse to accelerate the evaporation process. The greenhouse will have a prism shape roof. this shape aims optimization heating process. Greenhouse also equipped with a temperature sensor to find out room temperature, then a humidity sensor has a function to find out room humidity. The Fuzzy Logic Control method will control both sensors to meet setting of heat by

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PWM output. If the input value of temperature and humidity is very low or the condition at night, then the heating element will be activated, conversely if the value of the two inputs is too high then the heating element will be stopped as for the use of air pressure sensors that function to determine the air pressure in the room, the exhaust will light to dispose of hot air in a greenhouse, Water level control is used to determine evaporation rate.

2. Research Methods

2.1. System description

The whole system can see on Figure 1. Input on this system consist of some component and sensors. We using temperature, air pressure, humidity, LDR and water level control.

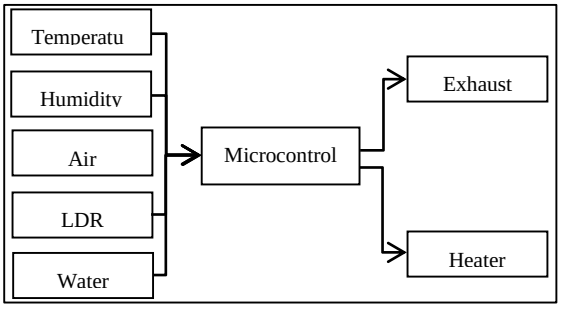


Figure 1. Diagram Block

This system has 3 parts, there is input, proses and output. Sub-section input consist of 5 part such as :

a. Temperature calculation is converting analog values from temperature sensors that have changed by the micro-controller.
b. Humidity calculation is converting analog values from humidity sensors that have changed by the micro-controller.
c. Pressure calculation is converting analog values from humidity sensors that have changed by the micro-controller
d. LDR to activate the heating system in a greenhouse Water level control is used to find out how much the value of evaporation that occurs from seawater to salt
e. Water level control is used to find out how much evaporation occurs from seawater to salt

2.2. Fuzzy Logic Controller

Method is an important part of the control process. Method of applying in this system is a fuzzy logic control. This method allows system to maintain ideal room temperature and humidity stability in the optimization process. In this research we apply Sugeno fuzzy method because this method has a linear equation output so it is very easy to apply. In this method there are some important parts in the form of determining the membership function of input and rule base. The membership function in this system is a function of temperature and humidity membership as shown in Figure 2 and Figure 3..

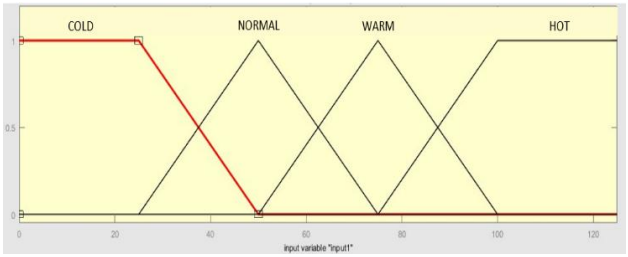


Figure 2. Temperature Membership Function

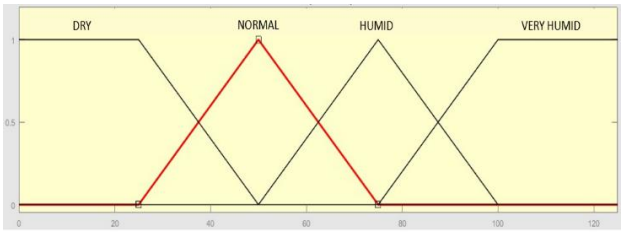


Figure 3. Humidity Membership Function

Temperature membership function consist of COLD, NORMAL, WARM and HOT. COLD have score range from 0 to 50, NORMAL have score range from 25 to 75, WARM from 50 to 100, HOT have score range from 75 to 100. Meanwhile humidity membership function consists of DRY, NORMAL, HUMID, and VERY HUMID. DRY have score range 0 to 50, NORMAL have score range 25 to 75, HUMID have score range 50 to 100, VERY HUMID have score range 75 to 100. Both of temperature membership functions represent the X function and the humidity membership function represents the Y function. Besides the two functions there is a Z function in the form of an output value in this system in the form of COLD (C) with a value of 0, NORMAL (N) with a value of 40, WARM (W) with value 80 and HOT (H) with a value of 120. Besides the membership function there is a rule base that has an important role in executing the fuzzy method. This rule base is in the form of rules performed in the fuzzy method. Rule base that has shown in Table 1.Table 1. Rule Base

X / Y	Cold	Normal	Warm	Hot
Dry	W	N	C	C
Normal	N	N	N	C
Humid	E	W	W	N
Very Humid	H	H	H	C

3. Result and Discussion

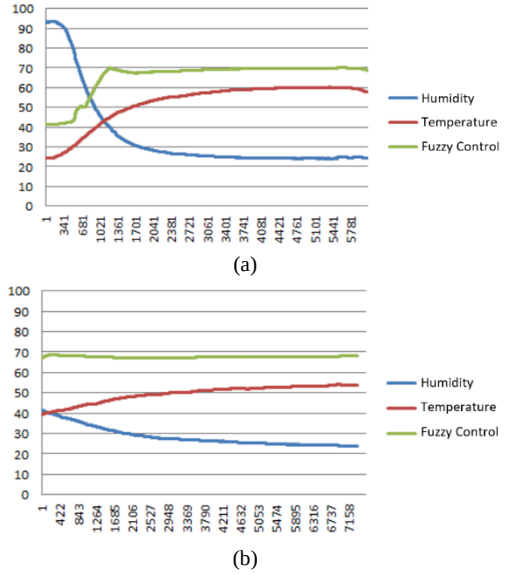
Trial using conventional methods and greenhouse technology methods. First step is to make sure shelter rack filled with salt solution. Salt solution has a salt content of 25-29 Be. There are 9 tests for each method. Salt solution conducted a trial with a volume 25 Liters, 23 Liters, 20 Liters, 18 Liters, 15 Liters, 13 Liters, 10 Liters, 8 Liters and 5 Liters. Trial conducted simultaneously as a comparison results of conventional methods and methods applied to the tool. Furthermore testing using conventional methods using solar energy as a source of heating or

evaporation process into salt. While the technology applied to greenhouse using heating elements that are controlled using temperature and humidity sensors. Trial results are shown in Table 2.

Table2. Test Result

No	Sampling test (Litre)	Time requirement		Producing Salt (Gram)	Note (Succeed / Fail)
		Conventional Methods (Days)	Fuzzy Methods (Days)		
1	25	20	5	875	Succeed
2	23	18	4,5	782	Succeed
3	20	16	4	700	Succeed
4	18	14	3,5	648	Succeed
5	15	12	3	525	Succeed
6	13	10	2,5	455	Succeed
7	10	7	2	350	Succeed
8	8	6	1,5	272	Succeed
9	5	3	1	175	Succeed

Based on overall test results, the system runs well. This is evidenced by the comparison of test result data. Data shows that the conventional method of the system takes longer than the system in the greenhouse. The method applied to the greenhouse is able to produce salt with a shorter time. Salt water with an amount of 25 liters can be used as salt with a period of 5 days with a normal time of 20 days. This shows the optimization of the process of evaporation of old salt water into salt using greenhouse technology supported by fuzzy methods that work well on the system. The success of the method in the system is shown in the graph of test results in Figures 4a and 4b.



(a)

(b)

Figure 4. (a) Daytime Result Testing. (b). Nights Testing Result

4. Conclusion

Overall, the system is working excellent. This condition supported by sensor readings with fast and accurate responses. The heating element works well so that the fuzzy method applied to the system runs well. Technology applied on greenhouses has shown very significant results. Applied methods running well to optimize evaporation of salt solution into salt. To ensure that we can use this system on a large scale it is necessary to calculate the process of production costs with the results obtained from production. This is to ensure that salt farmers benefit more by using this system.

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Effect of Rias Banana Fiber Percentage as Reinforcement of Polyester Matric Composite to Increase Waste Materials Become a High Value Functional Material

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A B S T R A C T

Along with the reduced use of metal in various materials, many new materials that have characteristics close to the metal have been developed for example in terms of tensile strength or other mechanical strength and have other advantages such as ease of manufacturing and low production costs. Composite is a material that formed from a minimum of two materials and usually has different mechanical properties to get new properties that are better than the ingredients. Each composite produces different properties depending on the matrix filler, type of filler and reinforcing material used. Rias banana fiber and wood sawdust available in large quantities need to be utilized better, for example for composite materials. This research can facilitate development in other fields because it has criteria to reduce metal imports, increase local product content, and increase foreign exchange if the product is exported. This study also supports government programs to increase independence in making independent products. The results of this study indicate that variations in the composition of composites made from rias banana fiber and teak sawdust with an epoxy matrix affect the mechanical properties of the composite. Hardness value increases with an increasing percentage of resin given. While the highest value of max strength is produced by composites with basic ingredients of 40% rias banana fiber, 20% teak sawdust and 40% epoxy. In this study it was concluded that the more resin given, the higher the composite hardness.

Keywords: Composite, Material, Epoxy, Natural Fiber, Rias Banana Fiber

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1. Introduction

Nowadays material needs are increasing and availability is decreasing. Along with the reduced use of metal materials in various products due to component weight, relatively difficult manufacturing processes, corrosive materials, and expensive production costs [1], many new materials have been developed that have characteristics close to the desired metal material for example in terms of tensile strength or other mechanical strength [2] and will have several advantages in other respects such as in terms of manufacturing ease and low production costs.

In this case, one of the superior materials is composite based material. Composite is a new material that is formed from a minimum of two materials and usually has different mechanical properties in order to obtain new properties that are better than the composite constituent material [3]. Composite consists of two main parts, namely the matrix as a composite binder or protector and the filler as a composite filler. Each composite will produce different properties depending on the matrix filler, filler type and reinforcement material used [4].

Natural fiber is an alternative filler for polymer matrix composites because it has several advantages over synthetic fibers. Natural fiber is easily obtained at a relatively cheaper price, easy to process, low density, environmentally friendly, and can be described biologically [5]. One of the abundant wastes of natural fiber is waste produced from the banana tree truncation which is usually only taken by the fruit, then the trunks are left alone. Banana makeup (the heart of a banana stem) is a part of a banana trunk located in the deepest part of a pile of pseudo-layered trees (*gedebog*), where the stem extends from the root to the end of the banana stem.

According to data from the Horticultural Production Center (2014) [6], the amount of banana production ranks highest, this is in line with the waste produced. Banana fruit with a production of 6,862,558 tons or around 34.65 percent of the total fruit production in Indonesia, contributes the largest to the national fruit production. The biggest banana production center is in Java, with production of 3,375,423 tons or around 49.19 percent of the total national banana production.

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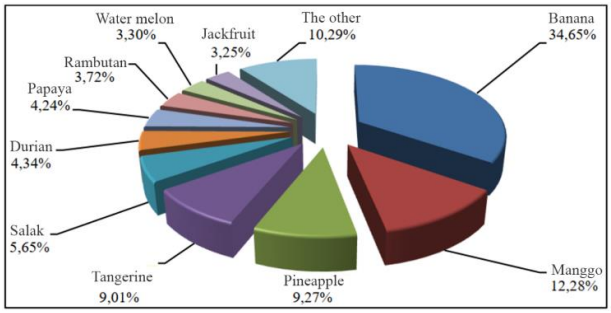

Figure 1. Percentage of Fruit Production in Indonesia in 2014
Resource*: Sentra ProduksiHoltikultura (SPH) 2014*

In addition to rias banana fiber waste, the availability of wood sawdust waste is also abundant in nature. Along with the increasing demand for wood for furniture, building materials, plywood, and various other needs, leaving a lot of wood waste. One of them is sawdust waste. The sawdust has not been used to the maximum and is usually only used as firewood or left alone into waste that is useless and pollutes the environment.

Sawdust is a type of natural fiber in the form of particles. The density of natural fibers is around 1.3 - 1.4 gr / cm3. Thus, the density of sawdust is almost the same as the density of fibers [7]. These natural materials have the potential to be engineered into more environmentally friendly technology products. Before it is used as a filler / reinforcement, wood sawdust needs to be charred first, because charcoal cannot be decomposed and is safe from wood-eating animals.

This shows that the rias banana fiber waste and wood sawdust available in large quantities need to be utilized better than just to be used as firewood. In addition, this research can facilitate development in other fields because it has criteria to reduce imports of finished metals, save foreign exchange, increase local product content, and increase foreign exchange if the product is exported. This study also supports government programs to increase independence in making independent products.

The element of science in this study is quite high, because it will be applied to a variety of tests of physical-mechanical properties. In the use of rias banana fibers, several treatments are carried out such as mixing with alkali (NaOH) in the hope that it can affect the resulting composite, because the alkaline function can eliminate existing lignin [8]. Furthermore, the carbonization process is also carried out on wood sawdust so that it cannot be broken down again.

The application of this knowledge is done to answer the needs of new materials that are environmentally friendly, have positive properties that are relevant to previous materials, in accordance with the needs of existing communities, and in accordance with applicable standards. New material produced from this research is expected to produce materials that are suitable to the needs of the community.

This research activity will also be able to strengthen the national innovation system, where one focus in the field of advanced materials is about supporting the transformation of waste materials and waste treatment as well as supporting structural materials. This research answers that focus where raw materials from composites as the core of this research are derived from natural waste which then transforms into new materials that can be applied in the industrial world.

Based on the description above, the research on a comprehensive study of functional materials based on cellulose fiber-based composite waste banana fiber - wood sawdust with epoxy matrix for functional material products is very interesting for further study.

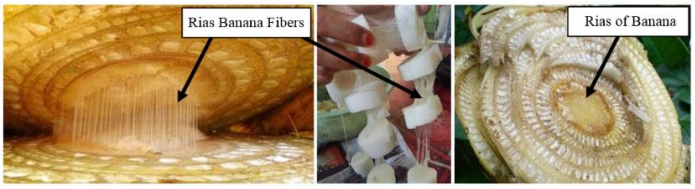

Figure 2. Rias of Banana

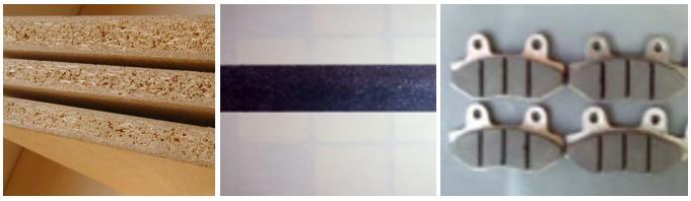

Figure 3. Examples of Composite Applications

2. Related work

Related to this research, previously Diharjo et al [9] had utilized kenaf fiber and sea sengon wood as engineering materials for making composite sandwich panels and acoustic panels. Furthermore Mamur LO, et al (2016) [10] have also conducted research on the mechanical properties of sago stem fiber composite material combined with teak sawdust with a polyester matrix in which from the results of this study it can be seen that the highest bending strength is found in the composite composite 40:30 : 30 that is 278,1268 N / mm2, and the lowest is in the 50:30:10 mixture composition of 118,87844 N / mm. While the highest tensile strength is in the 30:30 mixture composition of 31,059 N / mm2, the lowest is in the 40:10 mixture composition of 18,136 N / mm2. Researchers suggest that further research be carried out between teak sawdust and polyester resin.

Nopriantina and Astuti (2013) [11] concluded that the compressive strength value of pure polyester was 12.12 N / mm2 and the maximum compressive strength value of polyester composites after the addition of banana fiber fibers with an optimum thickness of 0.70 mm had a compressive strength of 12.92 N / mm2. The thicker the fiber is used, the compressive strength value will be better until it reaches the maximum point. The tensile strength value of pure polyester is 2.93 N / mm2 while the tensile strength of polyester composites is maximum value after the addition of banana frond fiber with an optimum thickness of 0.82 mm.

In the manufacture of PVC-CaCO3 composites with banana stem fiber powder as a filler can meet the requirements of SNI 15-0233-1989 Quality and Test Method for Cement Fiber Sheets. The effect of banana stem fiber powder as a PVC-CaCO3 composite filler, has been proven to increase tensile strength, hardness, water absorption, and flash point. Another effect is to reduce some mechanical properties, namely weight per unit area, weight content, flexural strength, water density, ability to be nailed and sawed. PVC-CaCO3 composite with banana stem fiber powder filler has various characteristics such as: unity weight area of 4.55-5.90 kg / m2, content weight 1.50-1.99 g / cm3, tensile strength 67.56–79 , 03 kg / cm2, hardness55,00-66,66 shore D, water absorption 0,96-3,32%, flexural strength 118,99–165,09 kg / cm2, flash point 0,03-0,07 inc / second, good water density (no droplets) and ability to be sawed and nailed well (not deformed / cracked) [12].

From the results of previous studies, the use of composites with banana stem fibers and sawdust have a good opportunity to be developed into composite materials for industrial needs such as car interiors. In this study, the banana stem part is more focused on cellulose fibers taken from banana stem dressing (banana stem hearts) which have a higher fiber content.

3. Methodology

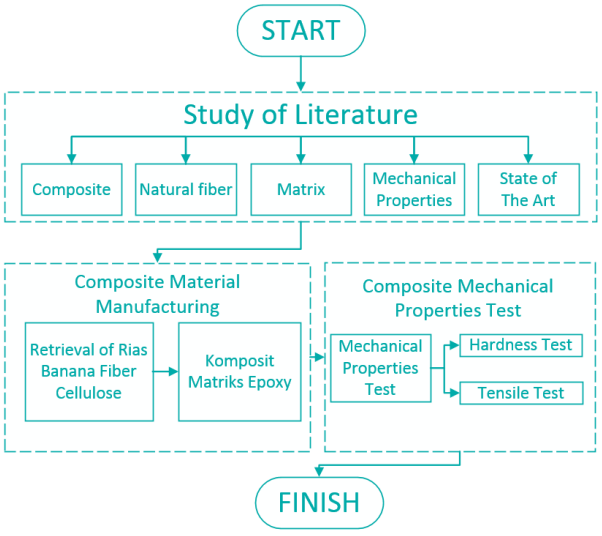

Figure 4. Flow Chart

In this study, it is divided into four steps as the foundation of the research, as follows.

3.1 Study of literature

Literature studies are used to deepen concepts and scientific studies of previous research. This literature study will focus on deepening the problem of composites, rias banana fiber waste, matrices and mechanical properties.

3.1 Study of literature

The next stage is making composite materials. Composite material is made using banana vanity fiber cellulose filler and sawdust which has been fabricated with epoxy matrix. The first step in making this specimen is to collect rias banana fibers and then dried in the sun to dry. Furthermore, the rias banana fibers were treated with alkali mixed with sawdust which has been made, mixed with epoxy matrix with a comparison according to the following table.

Table 1. Material Composition

Composite Composition			Sample Label			
Rias Banana Fiber (%)	Teak Sawdust (%)	Epoxy (%)	1	2	3	Average
50	20	30	A1	A2	A3	A
45	20	35	B1	B2	B3	B
40	20	40	C1	C2	C3	C
35	20	45	D1	D2	D3	D

Note:

1. Material A is a composite made with rias banana fiber, teak sawdust which has been made up and an epoxy matrix with a ratio of 50:20:30%.
2. Material B is a composite made with rias banana fiber, teak sawdust which has been made up and an epoxy matrix with a ratio of 45:20: 35%.
3. Material C is a composite made with rias banana fiber, teak sawdust which has been made up and an epoxy matrix with a ratio of 40:20:40%.
4. Material D is a composite made with rias banana fiber, teak sawdust which has been made up and an epoxy matrix with a ratio of 35:20:45%.

3.3 Test the Mechanical Properties of Composite Materials

Tests carried out to determine the mechanical properties of the sample. Tests to be carried out are tensile tests and hardness tests. Composite manufacturing is done by the hydraulic press printing method. The shape and geometry of the tensile test object refers to the ASTM D 3039 standard. Formation of the tensile test and hardness test is done manually by cutting composites using a hand grinder. Tensile testing uses the WDW-20 E. tensile testing machine. While the hardness test is carried out using the Rockwell hardness testing machine with the TH550 model.

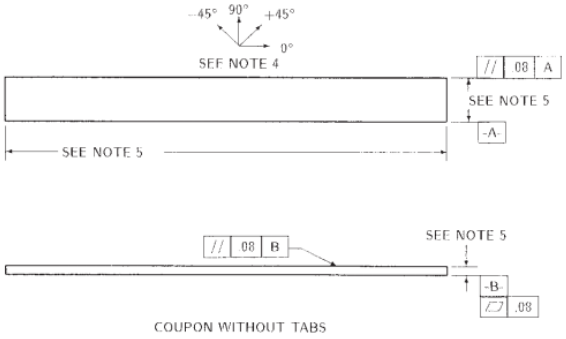

Figure 5. Image of Tensile Test Specimen without Notch

Figure 6. (a) WDW-20 E Tensile Test Equipment; **(b)** Rockwell Hardness Test Tool TH550

3.4 Tools and Materials

Tools

The tools used in this study are:

1. Furnace

2. Hardness test equipment
3. Impact test equipment
4. Machine Press
5. Scales
6. Sandpaper
7. Chainsaws
8. Drill Machine
9. Milling Machine
10. Stingy
11. Clamp Pliers
12. Composite dough container
13. Sifter
14. Water spray

Material

1. Rias Banana fiber
2. Epoxy matrix
3. Catalyst
4. Non-sticky wax matrix
5. ST 37 steel plate for mold

3.4 Research Variable

Independent variables: persentase serat dan resin

Dependent variable: hardness value dan max strength

4. Result and Discussion

In this study the sample used was four samples with three types of replication in each sample according to the explanation in Table 1. The purpose of replicating and repeating the test at different points for hardness testing is to obtain results that are close to the truth. In the hardness test, each replication is tested three times and taken on average so that the average final results of each test will be obtained as described in Figure 7 and Figure 8, while for tensile tests only one test is performed on each replication, because the specimen will break immediately at each test.

Each sample has a different surface texture. This is because of the difference in composition composites used. In sample A it has a more abrasive texture because there are fewer resins than other specimens, and vice versa. Sample D has a smoother texture because the portion of resin used is the most compared to other samples.

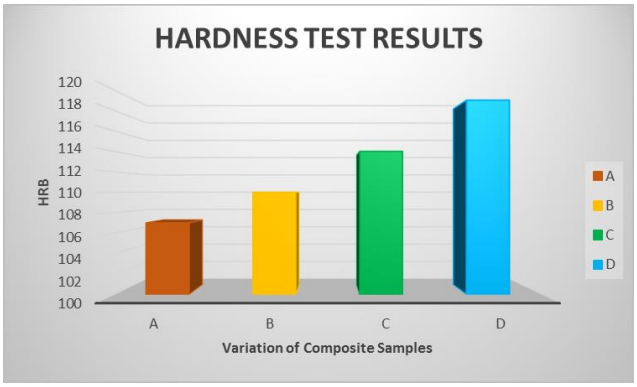

Figure 7. Rockwell hardness test results.

Based on the explanation in Figure 7, the results of Rockwell's hardness test can be described as follows.

1. Sample A has the lowest Rockwell hardness level (107 HRB)
2. Sample B has a Rockwell hardness level (110 HRB)
3. Sample C has a Rockwell hardness level (114 HRB)
4. Sample D has the highest Rockwell hardness level (119 HRB)

Based on Table. 1, sample D has the highest percentage of resins compared to samples A, B, and C. This opens the hypothesis that in this study, the higher the percentage of resin can affect the surface hardness value of the composite. This is because the particles become denser because the gaps between the particles of teak sawdust are filled with resin so that the hardness of the composite increases following the hardness of the resin. The second test carried out was a tensile test. This was done to determine the maximum tensile strength of the composite specimens made from epoxy teak sawdust. The test is carried out using the ASTM D 3039 standard. Tensile test results are described in the following Figure 8.

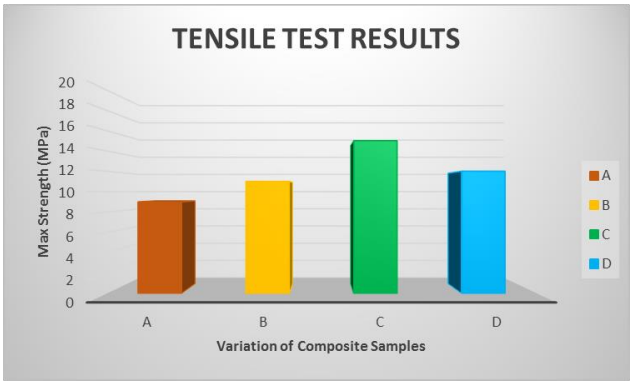

Figure 8. Tensile Test Results

Based on the explanation in Figure 8, the tensile test results show the Max Strength (MPa) value of each sample that has been tested is described as follows.

1. Sample A has the lowest Max Strength value (9 MPa) compared to the Max Strength value of samples B, C, and D.
2. Sample C has the highest Max Strength value (15 MPa) compared to the Max Strength value of samples A, B, and D.

5. Conclussion

Variation in the composition composition of composites made from rias banana fiber and teak sawdust with epoxy matrix affects the mechanical properties of the composite. The hardness value increases with increasing percentage of resin given to the composite. While the highest

max strength value is produced by composites with basic ingredients of rias banana fiber 40%, teak sawdust as much as 20% and epoxy as much as 40%. In this study it was concluded that the more resin specimens were given, the higher the hardness of the composites. As for the max strength, there is no known effect of the resin given.

Further research is needed to examine the characteristics of the mechanical properties of these composites to further be applied to functional materials such as brake disks, particle boards, car interiols, and other functional materials.

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Preventive Action to Make Zero Accident for Welding Process

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ABSTRACT

Each type of work has the risk of being affected by accidents or occupational diseases. These risks cannot be avoided, but can be minimized. Welding uses fire and flammable and explosive materials. Given the importance of Occupational, Safety and Health (OSH) in every workplace to increase work productivity, the implementation of OSH is the responsibility of all parties. Based on observations, many students were absent from lectures due to illness and some were exposed to gram splashes due to welding practices. Therefore, it is necessary to conduct further research on the application of Occupational health and safety culture as an effort to prevent accidents and diseases caused. The purpose of this research is to make procedure of preventive action on welding process. The research methodology consist of literature study, observation, make danger formulation and make critical assessment. The result of this research show that the highest RPN while the operator do welding.

Keywords: Action, Safety, Preventive, Welding, Zero accident.

Article History
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1. Introduction

Welding is a machining activity that has many risks both related to work accidents and occupational diseases. Each type of work has the risk of being affected by accidents or occupational diseases. These risks cannot be avoided, but can be minimized. Welding uses fire, flammable and explosive materials. Workplace accidents and diseases can be avoided if the welding operators comply with K3 ethics and are skilled at operating welding equipment well [1].

Considering the importance of OSH in each workplace to increase work productivity, the implementation of OSH is the responsibility of all parties to be applied in the workplace. Aside from being a necessity, in Law No. 1 of 1970 concerning occupational safety and health, explained that K3 is not only applied in the industrial world, but covers all aspects where there is a place to work. According to Law No. 1 of 1970, the laboratory is also a workplace that must be applied K3.

Diploma Study Program of Mechanical Engineering is a Higher Education that is engaged in the vocational field. In order to support student learning and teaching activities, this college has a laboratory and a workshop such as fabrication workshop. The workshop is used for welding practices where there are welding and grinding activities.

Figure 1. Welding Process

The fabrication workshop of this college actually has personal protective equipment used for the practice. These personal protective equipment include welding glasses, safety shoes, masks and aprons. But students are reluctant to comply with K3 ethics in the practice. Based on observations at the fabrication workshop, it is known that almost all students do not use safety shoes, masks, glasses, and aprons. The impact of this is that there are many students who are absent from other courses due to illness and someone who is exposed to a splash of bram. This is supported by the results of interviews from several lecturers where most of the lecturers had received permission not to enter because of complaints of eye pain after the welding practicum. Another lecturer also stated that there was also a permit because the students' eyes were exposed to a splash of bram. After checking the attendance list, it turned out that many students were unable to attend lectures due to illness. Of course this is very disturbing and can cause greater problems later on.

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Therefore, it is necessary to conduct further research regarding the application of K3 culture as an effort to prevent accidents and illnesses.

This study aims to design the prevention of accidents and diseases due to K3 welding practices considering 5S. This research is very much needed, so that accidents and illnesses caused by work when practicum can be minimized, besides that by applying OHS culture according to standards, students will be accustomed to implementing OHS and making it a necessity. Of course this will be very good for their stock to enter the workforce.

2. Research Methodology

The welding process is the process of joining 2 materials using metal melting. Welding is an activity that poses a high danger. The following is the research methodology used in this study

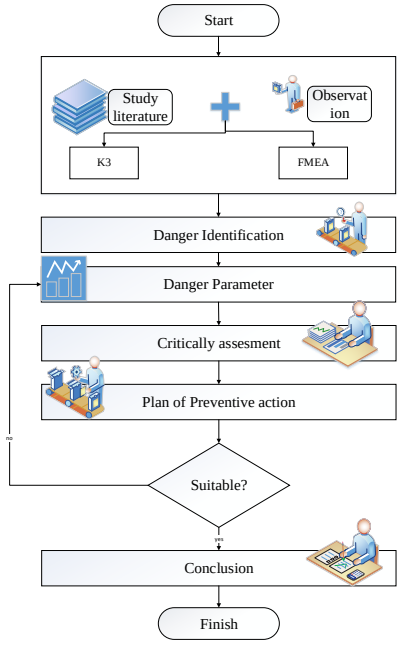

Figure 2. Research Methodology

Hazard identification stage is the stage used to identify any hazards arising from the welding practice process. In addition to hazards, at this stage a risk analysis of the impacts will also be carried out. Meanwhile, the determination of cost parameters is done by giving a scale based on risk, events, and their impact. At this stage it is based on the principles contained in the FMEA (Failure Mode Effect and Analysis).

3. Result and Discussion

Based on observations made at fabrication workshops and literature studies on hazards.

Table 1. Danger Identification

No	Procces	Danger Identification	Danger
1	Use PPE before work	Not use of PPE	Splashed welding flame, exposed to welding radiation, electric shock, eye pain, respiratory infections
		PPE that is owned is not complete	
		The number of PPE is limited	
2	Choose welding position	Welding table is not ergonomic	Muscle injury due to incorrect position, self-injury, eye pain
		The lighting is not good	
3	Preparing cable and tools	Equipment not in a fixed position (move to move as needed and position)	Gravitational to the risk of slipping or tripping over a cable
4	Turn on the engine panel box and adjust the electric current	- cable not maintained (peeled off)	- electric shock
		-cable position is not neat	- slip or fall
		-wrong method of holding electrodes	- exposed to sparks
		-Operator is not ready when the electrode is turned on	- radiation
5	Do the welding process	- Position when welding stand	- Muscle injuries
		- Welding movement are repeated	- Muscle injuries
		- Welding gas	- Respiratory tract infections, sore throat, lung infections
		- Sparks of flammable materials (gasoline, diesel, kerosene, etc)	- fire
		- The cable is chid	- muscle stimulation and pain
			- extreme pain
			- muscle contraction so that

No	Procces	Danger Identification	Danger
			victims affected by electric shock cannot escape without the help of others
6	Tidying up the equipment	Equipment security is not installed	Slipping, tripping, messy cables

Critical assessment is carried out by providing an assessment of the parameters of accidents and diseases due to the welding practice by calculating the value of the RPN. The RPN value is used as a benchmark to find out which risks need to be prioritized in planned preventative actions.

Table 2. Calculation of RPN (Risk Priority Number)

No	Procces	S	O	D	RPN
1	Use of PPE	6	7	6	252
2	Choose welding position	6	6	5	180
3	Prepare cable and equipment	5	5	5	125
4	Turn on the engine panel box and adjust the electric current	7	7	6	294
5	Do the welding process	9	8	7	504
6	Tidying up the equipment	4	4	5	80

Based on the table, obtained a sequence of severity values that result in high to low hazards are the welding process, turning on the engine panel box and adjusting the electric current, welding position, use of , preparing cables and equipment, and tidying the equipment.

Meanwhile, the sequence of occurrence values from highest to lowest values, namely carrying out the welding process, turning on the machine panel box and adjusting the electric current, the use of , welding position, preparing cables and equipment, and tidying the equipment.

The order of detection values from highest to lowest values is doing the welding process, turning on the machine panel box and adjusting the electric current, using , welding position, preparing cables and equipment, and tidying the equipment.

The value of Risk Priority Number (RPN) as a result of research on identifying the risk of welding hazard in a row from the highest to the lowest, namely welding process with a RPN value of 504, turning on the engine panel box and adjusting the electric current with a value of RPN 294, using with RPN value 252, welding position with a value of RPN 180, preparing cables and equipment with a value of RPN 180, and tidying up equipment with an RPN value of 80.

Based on the RPN value at the time of critical assessment, the RPN value with high risk is obtained when doing the welding. Preventive actions that can be taken to minimize the occurrence of these impacts by considering the RPN value are as follows

Prevention action of the welding dangers in general:

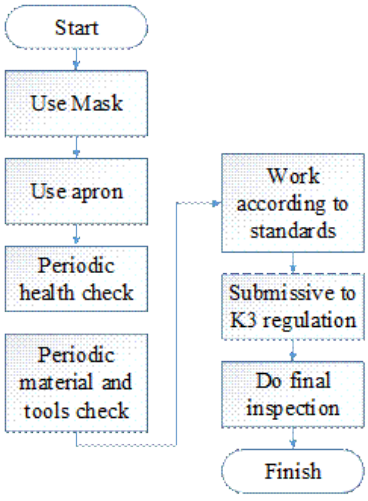

Figure 3. Preventive Action to Prevent Accident

Prevention action of shock due to the welding process takes place are:

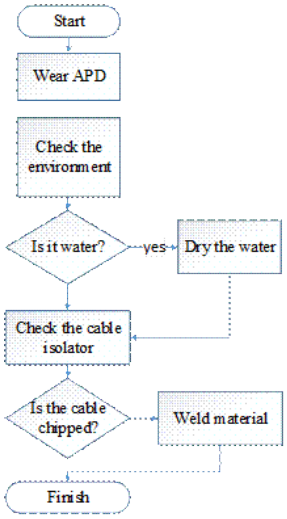

Figure 4. Preventive Action

Based on the OSHA (Occupational Safety and Health Administration), recommendations for the prevention of hazards caused by welding include:

1. Understanding welding material

In a welding process someone who conducts welding must understand the material used in welding. Because by knowing the material used, it can determine how the welding process is carried out, such as welding preparation, welding process / implementation, and finally finishing.

2. Clean the welding area regularly
   Welding spot cleaning is done to remove all impurities. Where the impurities can be in the form of paint, oil, dust, water etc. Dirt is cleaned to avoid welding damage during welding, and if cleaning is done will cause discontinuity. So that cleaning the welding area is needed to avoid things that are dangerous.
3. Provide air circulation to reduce the high hazardous substances in the welding workshop area
4. Use personal protective equipment () consists of:
   a. Helmet
   b. Safety shoes
   c. Goggles or welding helmets
   d. Hand protection
   e. Apron

4. Conclusion

Prevention of the impact of hazards caused by welding is important to do. Before determining the right handlers to overcome these impacts, a risk analysis using FMEA is needed. FMEA calculation results show that welding activities that pose the highest risk are the processes at the time of welding. To prevent the impact, welder must standard operating procedures in work, use , check the environmental conditions whether it is safe to do welding or not, and periodically check welder health.

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Analysis of Service Quality, Trust and Commitment to Customer Satisfaction and Loyalty in Madura Batik Products

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A B S T R A C T

Batik is a part of Indonesian culture. Since long ago, Batik cloth is still a fabric representing Indonesian culture. Batik cloth is also a national cloth that provides special features for Indonesia. In this research conducting analysis of service quality, consumer confidence, commitment to customer satisfaction and customer loyalty in Madura batik products. The method used is PLS (Part Least Square). Models formed with PLS can be optimal in prediction accuracy has a large complexity and samples ranging from 30 to 100 samples. This research is done in one of the districts in Madura Island, Bangkalan regency. In the district Bangkalan many SME batik that sells Madura batik products. Samples of consumers taken as much as 100. his research consists of two models namely model 1 about service quality, consumer confidence, commitment to customer satisfaction. Model 2 on service quality, consumer confidence, and commitment towards customer satisfaction to customer loyalty. From the results of The value of coefficient of determination of model 1 is 0.888 or 88.8%. In Model 2 the value of coefficient of determination of the Model 2 is 0.906 or at 90.6%. From the hypothesis test results that from Models 1 and 2 that have a significant influence is the commitment variable, while other variables have no effect. From the measurement goodness of fit acquired that the Model 1 and 2 is said to be a good overall model prediction

Keywords: Goodness of fit, Madura Batik, Part Least Square.

Article History
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1. Introduction

According to law Regulation number 20 year 2008, UMKM (Small and medium enterprises) consist of micro enterprise, small business, and medium enterprises. Micro-business is a productive business owned by individuals as well as individual business entities. Small business is a standalone productive economic endeavor, conducted by an individual or business entity that is not a subsidiary and not a branch of the company owned, mastered, or becomes part either directly or not From medium enterprises or large businesses. Medium Enterprises is a standalone productive economic endeavor, conducted by individual or business entity that is not a subsidiary or non-branch company owned, mastered, or becomes part either directly or not From medium enterprises or large businesses with net worth or yearly sales outcomes [1].

Batik is a painting or drawing on a Mori made using a tool called canting. The person who painted or drew on the canting Mori wears a batik called[2]. Batik industry in Madura, especially in the district Bangkalan consist of several SMES that belong to micro-enterprises. Madura batik industry comes from history so the batik center in Madura region is not too far from the palace because in the history of batik maker itself is a citizen among the palace.

Competition of batik sales in the Bangkalan itself has been growing, so that the entrepreneurs write not only batik, but also market the production results directly to the consumer or send it to various batik shops. Competition that strictly continues to provide evaluation to know the wishes of consumers to batik products. Batik producers continue to increase the number of customers so that the product is known to all consumers. In addition, batik producers want to be trusted producers in all consumers.

Batik entrepreneurs will continue to race the race in search of consumers as much as possible to make loyal consumers and trust in their products. Some that have been done by the party batik producers to increase the consumer is the improvement of service, quality of service, trust and others.

Based on the research [3] about the analysis of the service quality of Indihome internet at PT. X with Part Least Square stating that the tangible and responsiveness variables have no significant effect on the service quality of Indihome internet, While the empathy, assurance, and reliability variables affect the service quality of the Indihome Internet. Therefore, in this study wanted to know the influence of service quality, trust and commitment to customer satisfaction and loyalty. The purpose of this research to know the interpretation of customer about the products of Madura Batik especially in the district Bangkalan as the development of batik industry.

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2. Literature Review

2.1. Batik

Batik is the art of painting certain patterns on the cloth using various motifs, as well as colors. In each batik motif there are various meanings implied in it. In addition, batik is also an authentic Indonesian culture that has been known for a long time and characterizes traditional fashion. In the process of batik development is acculturation with other cultures so that it is seen in the changes of motifs and usefulness [4].

2.2. Service Quality

According [5], stated that the quality of service is an effort to fulfill the needs and wishes and accuracy in balancing consumer expectations. In addition, the quality of service is the defining element for the company in maintaining the consumer, where to realize a sense of comfort and have more value expected.

2.3. Trust

Trust is a psychological state of a person in conducting activities. Example of trust in making a product purchase. Trust also provides support in the process of purchasing the product to be done. Consumer confidence is a form of consumer support to the efforts made to get everything that is desirable. In addition, trust will provide support related to the purchase decision to be set [6].

2.4. Commitment

Commitment is customer's long-term orientation to business relationships. In addition, the commitment also consists of two types namely affective commitment, continuous commitment [7]. Commitment is also a desire to develop stable relationships and provide short-term sacrifices to be able to maintain relationships and believe in the stability of relationships [8].

2.5. Consumer Satisfaction

Consumer satisfaction is a result of conformity with the expectations that are perceived by users of products and services of the performance of a company. Consumers will be satisfied when their expectations can be fulfilled, and feel happy when expectations can be exceeded [8].

2.6. Consumer Loyalty

Loyalty is the ability of the company in positioning its products to customers, where the company is able to consider the customer as a means to provide stability for the confidence of the customer, the company also always interact, and also Development for Mutual progress [8]**.**

2.7. Part Least Square (PLS)

PLS (Partial Least Square) is a causal modeling approach that has a purpose to maximize the variances of latent variable criteria that can be explained (explained variance) By the variable latent predictors. Moreover, PLS (Partial Least Square) Also used for the creation and model development by using an approach that has orientation on the predictions. Models formed with PLS can be optimal in predictness accuracy has a large complexity and samples ranging from 30 to 100 samples [3]

3. Method

3.1. Sample

The study used samples of 100 consumers. Consumers who use the consumer who bought Madura Batik products in SMES in Bangkalan district.

3.2. Research framework

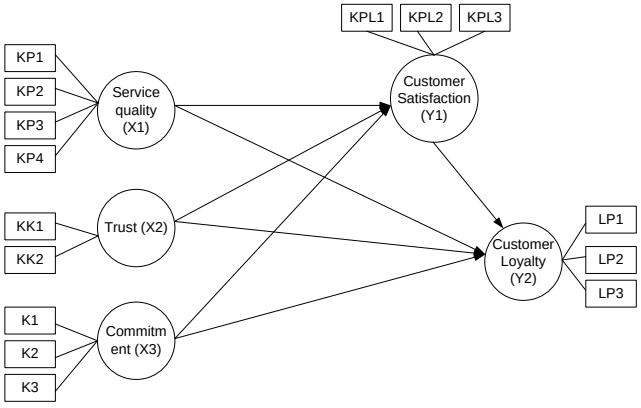

Figure 1. Research framework

3.3. Hypothesis

Based on the problems in the research and objectives, the hypotheses. Hypothesis of model 1 (service quality, customer trust, and commitment to customer satisfaction)

- Hypothesis of services quality to customer satisfaction (H1)
  H0: There is no influence between service quality to customer satisfaction.
  H1: There is an influence between service quality to customer satisfaction.
- Hypothesis of customer trust to customer satisfaction (H2)
  H0: There is no influence between customer trust to customer satisfaction.
  H1: There is an influence between customer trust to customer satisfaction.
- Hypothesis of commitment to customer satisfaction (H3)

H0: There is no influence between commitment to customer satisfaction.

H1: There is an influence between commitment to customer satisfaction

Hypothesis of model 2 (service quality, customer trust, and commitment, towards customer satisfaction to customer loyalty)

- Hypothesis of service quality to customer loyalty (H4)

  H0: There is no influence between service quality to customer loyalty.

  H1: There is an influence between service quality to customer loyalty.
- Hypothesis of customer trust to customer loyalty (H5)

  H0: There is no influence between customer trust to customer loyalty.

  H1: There is an influence between customer trust to customer loyalty.
- Hypothesis of commitment to customer loyalty (H6)

  H0: There is no influence between commitment to customer loyalty.

  H1: There is an influence between commitment to customer loyalty.
- Hypothesis of customer satisfaction to customer loyalty (H7)

  H0: There is no influence between customer satisfaction to customer loyalty.

  H1: There is an influence between customer satisfaction to customer loyalty.

  Decision making :

  If t value ≤1.96 then accept H_0

  if t value > 1.96 then reject H_0

3.4. Completion Stage

At Outer Model stage specify or define how each indicator reflects or illustrates its own variables. The tests performed on the outer model are:

- Convergent validity is the value of loading factor in latent variables with indicators. The value to be > 0,5
- Reliability construct of composite reliability and Cronbach alpha value > 0,7 For all latent variables.
- Validity of discrimination is to compare the value of square root of average variance extracted (AVE) of each construction with the correlation between other construct in the model. AVE value > 0,5
- Coefficient of determination value (R-squared) is used to demonstrate how large all exogenous variables describe the endogenous variable.
- *Estimate for path coefficients* Is the value of a line coefficient or also called a large latent influence or relationship. At this stage also created a regression equation :

  Model 1

  Y = ɣ1 KP + ɣ2 KK + ɣ3 K + Ç (1)

  Where :

  Y = customer satisfaction

  KP = service quality

  KK = customer trust

  K = commitment

  ɣ1... ɣ3 = Coefficient value for each variable

  Ç = error

  Model 1

  Y = ɣ1 KP + ɣ2 KK + ɣ3 K + ɣ4 KPL + Ç (2)

  Where :

  Y = customer loyalty

  KP = service quality

  KK = customer trust

  K = commitment

  KPL = customer satisfaction

  ɣ1... ɣ4 = Coefficient value for each variable

  Ç = error

The testing at Inner Model stage is:

- Conducting analysis GoF (*Goodness Fit* Index) to evaluate the measurement models and structural models and simple measurements for the overall prediction of this measurement model with communality value. The formula is:

$$GOF = \sqrt{\frac{communality}{n} \; x \; R^2} \qquad (3)$$

  Description:

  R^2 = Coefficient of determination value.

  n = number of variable

  Decision making:

  If GOF is worth 0.1 then it can be said GOF small, if worth 0.25 then it can be said medium and if it is worth 0.36 then it can be said large
- The inner model aims to know the significance of the influence between variables using the Bootstrapping method or also called a with T test. T statistical value used is = 1,96

4. Result and Discussion

4.1. Outer Model

Below is the result of the outer model PLS (*Part Least Square*) :

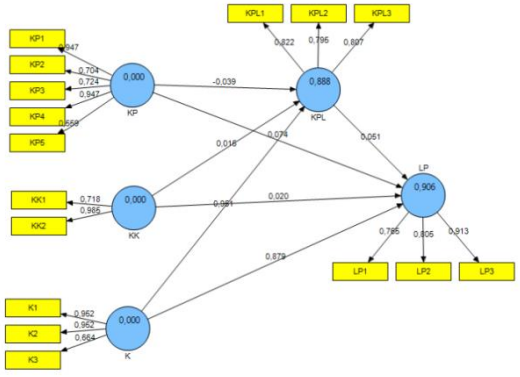

Figure 2. Outer model

- Testing Convergent Validity

  Decision making:

  If the value of loading factor is > 0.5 then the indicator reflects the variable.

Table 1. Loading Factor

No	Indicator	Loading factor
1	KP1	0,947

2	KP2	0.704
3	KP3	0.724
4	KP4	0.947
5	KP5	0.559
6	KK1	0.718
7	KK2	0.985
8	K1	0.952
9	K2	0.952
10	K3	0.664
11	KPL1	0.822
12	KPL2	0.795
13	KPL3	0.807
14	LP1	0.785
15	LP2	0.805
16	LP3	0.913

From the result of loading factor indicators > 0.5 then can be said to have all indicators can reflect the variable

- Reliability Construct
  Decision making :
  If the value of composite reliability or Cronbach's alpha > 0.7 then a model is said to have good validity and reliability

Table 2. composite reliability and cronbach's alpha

Indicator	Composite Relliability	Cronbachs Alpha
KP	0.889393	0.860095
KK	0.849339	0.739456
K	0.898455	0.819797
KPL	0.849486	0.747362
LP	0.868606	0.773337

On table 2 can be explained that the value of all variables latent, service quality, customer trust, commitment, customer satisfaction and customer loyalty have the value of composite reliability or Cronbach's alpha > 0.7 then a construct model is said to have good validity and reliability.

- Testing of discriminant validity
  Decision making :
  If the AVE value is > 0.5 then the construct model of the latent variable has a good validity.

Table 3. AVE

Indicator	AVE
KP	0.625293
KK	0.742793
K	0.75148
KPL	0.652978
LP	0.689053

From table 3 It is known that the AVE value of all the variables latent > 0.5 Then it can be said the construct model of the latent variables have good validity. Value of the coefficient of determination of the Model 1 is 0.888 or by 88.8%, meaning the exogenous latent variable of service quality, customer trust, commitment, to explain the endogenous latent variable of customer satisfaction of 88.8% while the remaining 11.2% is described by other variables not included in the research. Value of the coefficient of determination of the Model 2 is 0.906 or by 90.6%, meaning the exogenous latent variable of service quality, customer trust and commitment and customer satisfaction is able to explain the endogenous latent variables customer loyalty of 90.6% while the remaining 9.4% is explained by other variables not included in the researchn. Table 3 shown Estimate for path coefficients

Table 3. Estimate for path coefficients

Indicator	AVE
K->KPL	0.950654
K->LP	0.927756
KK->KPL	0.015397
KP->KPL	-0.038638
KP->LP	0.072415
KPL->LP	0.050901

So for the equation of the model as follows:

a. Model 1
   Y = ɣ1 KP + ɣ2 KK + ɣ3 K + Ϛ
   Y = -0,038KP + 0,015KK + 0,950K + Ϛ
b. Model 2
   Y = ɣ1 KP + ɣ2 KK + ɣ3 K + ɣ4 KPL + Ϛ
   Y = -0,038KP + 0,015KK + 0,950K + 0,050 KPL + Ϛ

4.2. Model Inner

Below is the result of an inner model PLS (*Part Least Square*) :

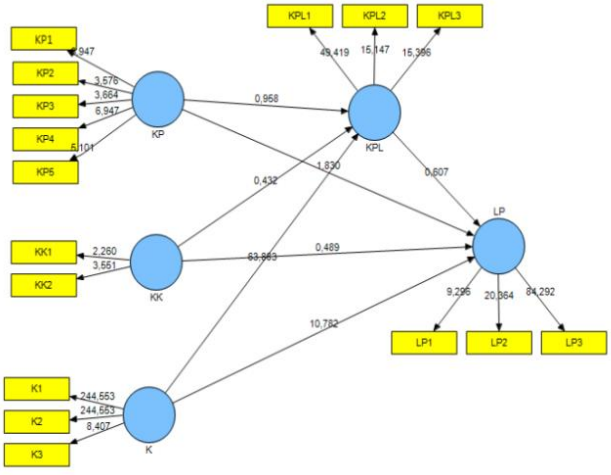

Figure 3. Inner model

a. *Goodness Of Fit* model 1

$$GOF = \sqrt{\frac{communality}{n}\ x\ R^2}$$

$$GOF = \sqrt{\left(\frac{0,625+0,742+0,751+0,652}{4}\right)\ x\ 0,888} = 0,784$$

b. *Goodness Of Fit* model 1

$$GOF = \sqrt{\frac{communality}{n}\ x\ R^2}$$

$$GOF = \sqrt{\left(\frac{0,625+0,742+0,751+0,652+0,689}{5}\right)\ x\ 0,906} = 0,791$$

Based on the calculation of GOF values on models 1 and 2 obtained values of 0.784 and 0.791 and large value which means that the model PLS made can be said overall prediction model good.

c. Hypothesis testing of model 1 (the influence of latent variable service quality, customer trust, and commitment to customer satisfaction)

- Hypothesis of service quality (H1)
  The t value of the service quality is 0,957 < 1,96 then accept H_0 means there is no influence between the service quality to customer satisfaction
- Hypothesis of customer trust (H2)
  The t value of the customer trust is 0,4323 < 1,96 then accept H_0 means there is no influence between the customer trust to customer satisfaction
- Hypothesis of commitment (H3)
  The t value of commitment is 63,88 > 1,96 then reject H_0 means there is an influence between the commitment to customer satisfaction

d. Hypothesis testing of model 1 (the influence of latent variable service quality, customer trust, and commitment towards customer satisfaction to customer loyalty)

- Hypothesis of service quality (H4)
  The t value of the service quality is 1,833 < 1,96 then accept H_0 means there is no influence between the service quality to customer loyalty.
- Hypothesis of customer trust (H5)
  The t value of the customer trust is 0,516< 1,96 then accept H_0 means there is no influence between the customer trust to customer loyalty.
- Hypothesis of commitment (H6)
  The t value of commitment is 39,56> 1,96 then reject

H_0 means there is an influence between the commitment to customer loyalty.

- Hypothesis of customer satisfaction (H7)

The t value of customer satisfaction is 0,607< 1,96 then accept H_0 means there is no influence between the customer satisfaction to customer loyalty.

5. Conclusion

In the results of the study acquired that on the outer model of the loading factor value of the indicator is able to explain all the variables due to the value of all the > 0.5. The validity testing of the construct model, unknown to the construct model of the latent variable has a good validity due to the AVE value of all the latent variables > 0.5. The value of coefficient of determination of model 1 is 0.888 or 88.8%, meaning that the exogenous latent variable is the quality of service, the confidence of consumers and the commitment to explain the endogenous latent variable that is consumer satisfaction of 88.8%. In Model 2 the value of coefficient of determination of the Model 2 is 0.906 or at 90.6%. From the hypothesis test results that from Models 1 and 2 that have a significant influence is the commitment variable, while other variables have no effect. From the measurement goodness of fit acquired that the Model 1 and 2 is said to be a good overall model prediction.

Acknowledgements

In future research, it is required strategy in variable sales and development of strategy management as a guideline in improving batik sales service. It is also necessary to pay attention to consumer behaviour in determining the next variable.

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The Calculation of Ni-Sn-W Alloy Phase Diagram Using CALPHAD Method As New Soldering Material

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A B S T R A C T

The Ni-Sn-W Alloy becomes an alternative as the Ni element could slow and block the forming of intermetalic. Beside, the existence of the W element could add the solder materials performance which is able to block the forming of intermetalic substance. Calculation of phase diagram (CALPHAD) is able to become a solution for the limited information about phase diagram whether two system (biner) or others systems above. Computing method of CALPHAD used the factual approach and assumed that it is the characteristic of thermodynamic. From the calculation, the result gained are Ni_3Sn, Ni_3Sn_2, Ni_3Sn_4, solidus Sn (Sn), solidus Ni (Ni), NiW, Ni_4W, solidus W (W), and solidus liquid (L).

Keywords: Ni-Sn-W, Calphad, Phase Equilibria

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1. Introduction

The selection of substance materials Alloy is an important part in understanding the development of materials especially as the alternative materials and the material substitution for existing material. It needs much experiment and time to understand and determine one material Alloy.

The Sn-Pb Alloy has a unique attraction especially in electronic. The melting temperature is relatively low in the area of eutectic (183ºC) makes the Sn-Pb becomes irreplaceable materials. However, European Union Waste Electrical and Electronic Equipment Directive (WEEE) dan Restriction of Hazardous Substances Directive (RoHS) has banned the use of timbale on electronic device because it contained toxic which endangers the environment on June 2006 [1-2].

Sn is a main substance of the free timbale solder due to the electroplated Sn layer on substart is able to raise the wettability between subtract and solder. Nikel (Ni) is considered as the barrier because it has low reactivity. It makes the materials Sn/Ni often used as diffusion barrier materials on the connection of Under Bump Metallization (UBM) and Ball Grid Away (BGA0 during the process of soldering. The interfacial between melted solder materials and subtract happen and produces intermetalic substance (IMC) on the interface. IMC is formed during the process of soldering which give transformation phase effect. The development of IMC and its characteristic will influence the reliability of solder connectivity [3].

The existence of Ni will reduce the development of IMC because the Ni layer is diffused right before the interfacial process with the solder. To reduce the development of IMC between Ni and solder materials, minor materials like P, B, Co, Mo or W needed to add into the Sn-Ni alloy [4].

Tungsten (W) attracted attentionin recent years because it has high level of melting (3422ºC), good heat stabilization, and low diffusion coefficient to Ni [5]. Adding the W will make the Alloy more stable in high temperature. The W has high potential to combine with Ni and the Ni-W alloy is used as diffusion barrier materials.

To understand the interfacial reaction, phase diagram is the only tool to use. So far, there is only one information about the equilibrium phase from the Ni-Sn-W alloy component on 750 ºC known. The lack of information about the equilibrium phase on the component of the Ni-Sn-W alloy becomes obstacle to understand the interfacial reaction exists. To handle that, thermodynamic approach using CALPHAD is a solution to predict equilibrium phase to some temperature

The Ni-Sn-W alloy is an alternative due to the Ni element in it which cloud slow and block the forming of intermetalic substance. Besides, the existence of W element could add the ability of solder material and becomes additional barrier of intermetalic substance.

To determine alloy of each element and to understand the phase formed during the heating process due to soldering process, the understanding of phase diagram is important. The limited information and the lack of research on phase on the Ni-Sn-W alloy especially and the other three systems in general become obstacle of the development of materials

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Calculation of phase diagram (CALPHAD is one of the solutions for the lack of information about phase diagram for both systems, biner, or others systems above [8]. Computing method of CALPHAAD uses factual methods and seen as a phase diagram of thermodynamic. For short, calculate the phase diagram with thermodynamic to all phase in a system is possible

2. Methodology

The phase flow chart calculation using CALPHAD shown on the picture1. The first step for producing the thermodynamic calculation is by finding the phase diagram data like solidus and liquidus temperature, enthalpy, hot capacity, and crystallographic from each solid phase. Energy Gibbs model for every phase according to the different crystal structure. Data from the experiment needed for gaining the data of the optimal thermodynamic. The data gained is used to calculate the phase diagram from the temary Ni-Sn-W on different temperature.

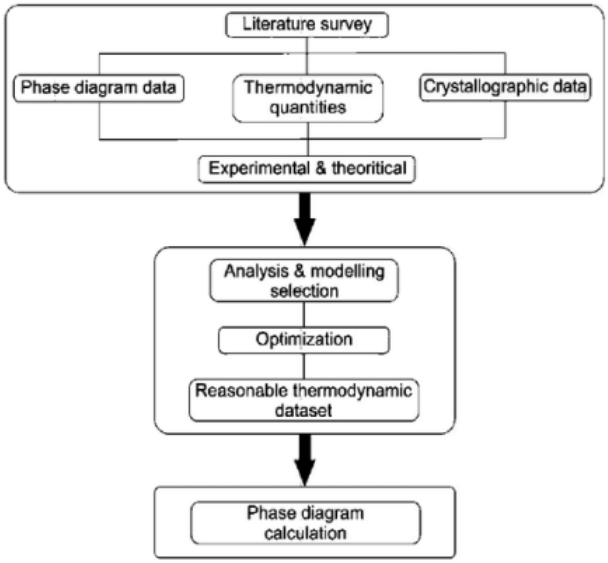

Figure 1. The flow chart of CALPHAD calculation method

2.1. Thermodyamic model

On the model of thermodynamic, a selection of phase from each must be selected. Each phase is needed for different model of thermodynamic

2.1.1. Unary phase

The different Gibbs energy for pure element on the phase ϕ and the reference of stable element (SER) from *i* if formulated below:

$$G_i^{0,\phi}(\mathrm{T}) = G_i^{\phi}(\mathrm{T}) - H_i^{SER} \quad (1)$$

Which

$G_i^{0,\phi}(T)$: Gibbs energy of pure element of Gibbs phase ϕ.

H_i^{SER} : enthalpy of element *I* on standard condition, P = 1 bar and T = 298.15 K.

The above similarity (1) above is formulated as follows;

$$G_i^{0,\phi}(T) = a + bT + cT\,lnT + \sum n\,dT^n \quad (2)$$

which the parameter score a, b, c,…taken from SGTE (Scentific Group Thermodata Europe) [9].

2.1.2. Sholidus phase

The solidus phase consists of liquid phase, FCC, HCP, dan BCC modeled by single-lattice random solution.This model is the function of temperature and Alloy.

$$G_m^{\phi}(T) = \sum_{i=1}^{n} x_i . G_i^{0,\phi} + RT \sum_{i=1}^{n} x_i . ln(x_i) + {}^{ex}G^{\phi} \quad (3)$$

$${}^{ex}G^{\phi} = \sum \sum x_i^{\phi} x_i^{\phi} L_{i,i}^{\phi}$$

which xi is a fraction mol from *i* element, R is the gas Constanta (8,3145 J/mol K), ${}^{ex}G^{\phi}$ is surplus Gibbs energy from a phase, and, $L_{i,j}^{\phi}$ is the interaction of *i* and *j* elements. Parameter interaction $L_{i,j}^{\phi}$ could be formulated by using the formula of Redlich-Klister:

$$L_{i,i}^{\phi} = \sum_k {}^k L_{i,i}^{\phi} (x_i^{\phi} - x_i^{\phi})^k \quad (4)$$

$$L_{i,i}^{k,\phi} = a^k + bT^k$$

The parameter interaction is also influenced by Alloy and temperature. .

2.1.3. Stoikiometry ubstance

The different Gibbs energy for pure element on the phase ϕ and the reference of stable element (SER) from *i* if formulated.

For the intermetalic, the energy Gibbs is formulated as follows:

$$G = \sum_{i=1}^{n} x_i G_i^{0,\phi} + G_f \quad (5)$$

Which Gf is Gibbs energy for the form of Stoikiometri Substance.

3. Result and Discussion

The result of experiment on *phase equilibria* system the Ni-Sn-W alloy on the temperature 750ºC was introduced for the first in 2016. The method used on that research was *arc melting*. The number is 21 metals alloy with Ni – Sn – W alloy. The different alloy were applied by using asc melting up to 6 times melting sintering. Each metal alloy is put into glass cube and vacuumed to avoid the contamination on the sintering process. Then each metal Alloy heated into 750ºC for 720 hours. Beside, each sample is quenched with water. The quenched metal then analyzed

using Scanning Electron Microscopy (SEM) with energy dispersive spectroscopy (EDS), and x-ray diffraction analysis (XRD) temperature for the next identified phase formed on temperature of 750ºC [5].

Phase formed on the temperature of 750ºC are Ni_3Sn, Ni_3Sn_2, Ni_3Sn_4, solidus Sn (Sn), solidus Ni (Ni), NiW_2, NiW, Ni_4W, solidus W (W), and solidus liquid (L). On the equilibrium phase, it could be concluded that Ni-Sn-W on the temperature of 750 ºC has 9 single phases, 13 double phases, and 7 three areas. Meanwhile, *ternary* was not found IMC on system of Ni-Sn-W on the temperature of 750ºC [7]

The phase diagram calculation of ternary Ni-Sn-W using CALPHAD method referenced on the result of experiment existed. For the Biner phase Ni-Sn using thermodynamic from liu [6] and Popovic for Ni-W [7]. For W-Sn phase was not calculated and assumed as perfect solidus.

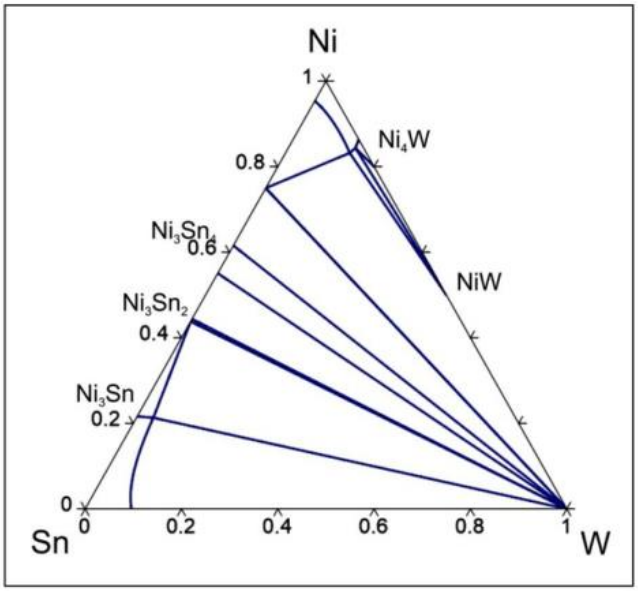

Figure 2. Equilibrium Phase Calculation on Ni-Sn-W on the temperature of 750ºC.

The picture 2 above shows the result of calculation of Equilibrium Phase from Ni-Sn-W on the temperature 750ºC and Table 1 shows the thermodinamic parameter. From the result is gained that Ni_3Sn, Ni_3Sn_2, Ni_3Sn_4, solidus Sn (Sn), solidus Ni (Ni), NiW, Ni_4W, solidus W (W), and solidus liquid (L) as the result of research conducted by Hermana [5].. The previous calculation still needed data reparation and addition from the unpublished experiments.

Table 1. **Ni-Sn-W Thermodynamic Parameter**

Phase	Model	Parameter	Ref
Liquid	(Ni,Sn,W)	${}^0L^{liquid}_{Ni:Sn}$ = -105002.87+197.8089 T-21.6959 T Ln(T)	[6]
		${}^1L^{liquid}_{Ni:Sn}$ = -28342.17+52.5528 T-7.56094 T Ln(T)	[6]
		${}^2L^{liquid}_{Ni:Sn}$ = 5582.31	[6]
		${}^0L^{liquid}_{Ni:W}$ =16290-10.25 T	[7]
		${}^1L^{liquid}_{Ni:W}$ = -22450	[7]
FCC	(Ni,Sn,W) : (Va)	${}^0L^{fcc}_{Ni,Sn:Va}$ = -69460.28+77.6267 T-8.89084 T Ln(T)	[6]
		${}^1L^{fcc}_{Ni,Sn:Va}$ = -8295.19	[6]
		${}^0T^{fcc}_{Ni,Sn:Va}$ = -6000	[6]
		${}^1T^{fcc}_{Ni,Sn:Va}$ = 3000	[6]
		${}^0L^{fcc}_{Ni,W:Va}$ = 2556+11.6 T	[7]
		${}^1L^{fcc}_{Ni,W:Va}$ = -52900	[7]
BCC	(Ni,W):(Va)	${}^0L^{bcc}_{Ni,W:Va}$ = 82000	[7]
Ni_3Sn_HT	$(Ni,Sn)_{0.25}$:$(Ni,Sn)_{0.25}$:$(Ni)_{0.5}$	${}^0G^{Ni_3Sn\_HT}_{Ni:Ni:Ni}$ = ${}^0G^{fcc}_{Ni}$	[6]
		${}^0G^{Ni_3Sn\_HT}_{Ni:Ni:Sn}$ = 13557.12-2.4434	[6]
		${}^0G^{Ni_3Sn\_HT}_{Ni:Sn:Ni}$ = -21744.79+1.7049	[6]
		${}^0G^{Ni_3Sn\_HT}_{Sn:Sn:Ni}$ = 24069.79+12.1937	[6]
		${}^0L^{Ni_3Sn\_HT}_{Ni:Sn:Ni}$ = -16726.09	[6]
		${}^1L^{Ni_3Sn\_HT}_{Ni:Sn:Ni}$ = 6635.72	[6]
Ni_3Sn_2 _HT	$(Ni)_{0.33}$:$(Ni,Sn)_{0.33}$:$(Sn)_{0.33}$	${}^0G^{Ni_3Sn_2\_HT}_{Ni:Ni:Sn}$ = -22448.65+0.2828	[6]
		${}^0G^{Ni_3Sn_2\_HT}_{Ni:Sn:Sn}$ = -4935.38+7.5571	[6]
		${}^0G^{Ni_3Sn_2\_HT}_{Sn:Sn:Sn}$ = -78783.2	[6]
Ni_3Sn_4	$(Ni)_{0.25}$:$(Ni,Sn)_{0.25}$:$(Sn)_{0.5}$	${}^0G^{Ni_3Sn_4}_{Ni:Ni:Ni}$ = -26138.15+4.912 T+0.5	[6]
		${}^0G^{Ni_3Sn_4}_{Ni:Ni:Sn}$ = 7613.24+8.749	[6]
		${}^0G^{Ni_3Sn_4}_{Ni:Sn:Sn}$ = -50828.16	[6]
Ni_4W	$(Ni)_4$: (W)	${}^0G^{Ni_4W}_{Ni:Ni:Ni:W}$ = -12862-4.747 T+4${}^0G^{fcc}_{Ni}$+${}^0G^{bcc}_{W}$	[7]
NiW	(Ni): (W)	${}^0G^{NiW}_{Ni:W}$ = -8885.91+3 T+${}^0G^{fcc}_{Ni}$+${}^0G^{bcc}_{W}$	[7]
NiW_2	(Ni): $(W)_2$	${}^0G^{NiW_2}_{Ni:W}$ = -8888.282+3T+${}^0G^{fcc}_{Ni}$+ 2${}^0G^{bcc}_{W}$	[7]

4. Conclusion

The phase of equilibrium calculation on Ni-Sn-W has done successfully. The phase form on the temperature of 750 ºC are phase of Ni_3Sn, Ni_3Sn_2, Ni_3Sn_4, solidus Sn (Sn), solidus Ni (Ni), NiW, Ni_4W, solidus W (W), and solidus liquid (L) as the previous experiments, the result is categorized satisfied as the lack of experiments on Ni-Sn-W

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Analysis of Working Position Improvement to Minimize Musculoskeletal Disorder for Furniture Workers In UD. Jati Semi Dusun Sudimoro District of Nganjuk

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A B S T R A C T

Musculoskeletal disorder is one of the risks due to improper working position. The most common problems in UD. Jati Semi were started from woodcutting up to finishing processes were the poor material arrangement, unergonomic working position, and dust from the wood cutting process. The risk assessment was performed by HIRA (Hazard Identification, Risk Assessment) method. The results showed that there were 4 risks in the accepted category, 1 risk in the moderate category, and 3 risks in the unaccepted category. The methods for analyzing working postures were performed by RULA (Rapid Upper Limb Assessment) and OWAS (Ovako Work Posture Analysis). The RULA results showed that the first installation and the cutting processes were classified as high-risk category, the second installation and the machine sanding processes were classified as the moderate-risk category, and the engraving by machine, the manual engraving, and the staining processes were classified as small-risk category. The OWAS results showed that the first installation, the sanding by machine, the engraving by machine, and the second installation processes were classified as the moderate category, the staining process was classified as quite category, the cutting process was classified as the highest category , and the engraving process was classified as the low category.

Keywords: Musculoskeletal disorder, HIRA (Hazard Identification, Risk Assessment), RULA (Rapid Upper Limb Assessment), OWAS (Ovako Work Posture Analysis)

Article History
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1. Introduction

According to Rahawarin (2011) in Randang's research (2017) that unergonomics of work attitudes in working especially kind of work are using high workforce, repetitive activities, and excessive muscle stretching can cause musculoskeletal disorder potentially. The worker will feel muscle pain, aches, and pain in the bone joints, tendons, nerves, and other muscular systems. [1]

Musculoskeletal disorder is one of the health problems for workers that can cause temporary or permanent disability working. Several studies have mentioned that the factors causing Musculoskeletal disorders (MSDs) are lack of work posture, high workload, work culture, and repetitive activities. [2]

The furniture industry is one of the industries which is growing rapidly in Indonesia. The raw and semi-finished materials management to be of high value for users are economic activities which are included in the industrial design. The furniture industry in Indonesia is spread almost in all provinces, both in Java or outside of Java. [3]

One of the furniture industries in Nganjuk district is UD. Jati Semi. It is located in Dusun Sudimono Nganjuk district. The furniture production processes are started from cutting wood, construction, sanding, installation until finishing. The using of the traditional machine is still used in the process. The situation requires the expertise of craftsmen or furniture worker. So the workers have to stay fit and be careful when they are working so as not to affect work productivity.

The design and quality of furniture products need to be considered by craftsman furniture. So, the craftsman needs to be careful in the production process. One of the causes of working errors is human error and working environment conditions. Safe and comfortable working environment cause the workers can be working for long hours. The improper conditions potentially make the workers get Musculoskeletal disorder (muscle injuries). [4]

Occupational Health and Safety is one of the requirements to improve the working productivity of workers which is related to production results. In general, work accidents caused by two factors, the environmental factor, and the human factor. The human factor is unsafety action and posture and the environment factor is unsafety conditions and working environment including equipment and workplaces. [5]

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Occupational Health and Safety is a protective effort aimed at ensuring that workers are always safe and healthy in the workplace and each production is used safely and efficiently. [6]

From an initial survey of 10 furniture employees, it was found that all employees experienced muscle pain in the neck, hands, shoulders, legs, and back. For this reason, a method is needed to solve the problems experienced by furniture employees in order to increase productivity.

This aims of the study are to decrease musculoskeletal disorder risk by risk measured using HIRA (Hazard Identification, Risk Assessment) method, body posture analyse by using RULA (Rapid Upper Limb Assessment) method and OWAS (Ovako Work Posture Analysis).

2. Methods

This research is descriptive research. Descriptive research is research that discusses a number of data which is then analyzed and further analyzed about the research carried out in order to solve existing problems. [6]. This study begins with a publication that discusses the issue of hazards in the work environment with the HIRA method, data conversion is done by conducting interviews with 10 employees of UD Jati Semi furniture. Apart from environmental factors, next is the approval of K3 (Occupational Safety and Health) which is seen from human factors. The initial survey conducted was preliminary data using the Nordic Body Map questionnaire. From the results of the questionnaire examination, there were musculoskeletal complaints that were often attended by the employees, pain in the hands, pain in the back, stiffness in the upper neck and shoulders. To analyze complaints experienced by employees, the RULA (Rapid Upper Limb Assessment) and OWAS (Ovako Work Posture Analysis) methods are used to ensure the safety of employee work postures.

The evaluation is carried out by analyzing the work posture with RULA and OWAS worksheets to find a safe work posture, then using the Nordic Body Map questionnaire distributed before and discussing the improvement, whether the company still needs help with musculoskeletal disorders or not. then poured into the Nordic Body Map questionnaire.

2.1. HIRA

Refer to Hazard Identification and Risk Assessment workbook published by Ministry of Community Safety and Correctional Services Ontario Canada HIRA is defined as: A risk assessment tool that can be used to assess which hazards pose the greatest risk in terms of how likely they are to occur and how great their potential impact may be. It is not intended to be used as a prediction tool to determine which hazard will cause the next emergency. There are four steps to create and maintain a HIRA.[7]

- Hazard Identification
- Monitor and Review
- Risk Analysis
- Risk Assessment

2.2. Rapid Upper Limb Assessment

RULA was developed without the need for special equipment. This provided the opportunity for a number of investigators to be trained in doing the assessments without additional equipment expenditure. As the investigator only requires a clipboard and pen, RULA assessments can be done in confined workplaces without disruption to the workforce. Those who are trained to use it do not need previous skills in observation techniques although this would be an advantage.[8]

The RULA method comprises three stages: 1) the recording of working posture; 2) the scoring system; and 3) the scale of action levels. This method analyzes two parts of the body: Part A consists of the upper and lower arm and wrist; Part B consists of the neck, trunk, and legs. RULA is based on the OWAS system. According to this methodology, posture score is calculated for each body part. Based on the total score, four action levels, indicating the level of intervention required to reduce the risk of injury, are suggested: Action level 1: posture is acceptable; Action level 2: further investigation is needed and changes may be needed; Action level 3: investigation and changes are required soon; and Action level 4: investigation and changes are required[9]

2.3. Ovako work posture analysis

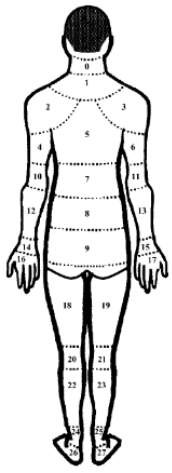
OWAS is a simple method to verify safety level which related to work posture, and to evaluate risk level which leads to corrective action. OWAS method can define the movement of all parts of the body and can recommends suggestion to safer and comforter feeling while working.[10]

Owas Analysis :

1. Record the images of the work postures to be analyzed.
2. Classify and score the posture for each job examined, including back, arms, feet, and load. Classification of postures to be analysed on OWAS method are back, arms, feet, and load.
3. Calculate the work posture score with OWAS table.
4. Categorize the OWAS score of 1) Category 1: Improvements are not necessary, 2) Category 2 : Improvements are necessary in the longterm future, 3) Category 3 : Improvements are necessary as soon as possible, and 4) Category 4 : Implement improvements now.

2.4. Nordic body map questionnaire

Nordic Body Map (NBM) is a body map that can identify parts of muscle or joint which resulted to complaints from the workers. NBM divided body parts into numbering from 0 to 27 which covering from neck to feet. NBM questionnaire was gave to and filled by six workers working in the factory.[10]



No	Location	Grade of complaints			
		A	B	C	D
0	Pain/stiff in the upper neck				
1	Pain in the lower neck				
2	Pain in the left shoulder				
3	Pain in the right shoulder				
4	Pain in the left upper arm				
5	Pain in the back				
6	Pain in the right upper arm				
7	Pain in the waist				
8	Pain in the buttock				
9	Pain in the bottom				
10	Pain in the left elbow				
11	Pain in the right elbow				
12	Pain in the left lower arm				
13	Pain in the right lower arm				
14	Pain in the left wrist				
15	Pain in the right wrist				
16	Pain in the left hand				
17	Pain in the right hand				
18	Pain in the left thigh				
19	Pain in the right thigh				
20	Pain in the left knee				
21	Pain in the right knee				
22	Pain in the left calf				
23	Pain in the right calf				
24	Pain in the left ankle				
25	Pain in the right ankle				
26	Pain in the left foot				
27	Pain in the right foot				

Figure 1. questionnaire body mapping

3. Results and analysis

3.1. Musculoskeletal disorder survey

The NBM questionnaires were distributed to 10 furniture workers and the results showed that all the furniture workers got muscular disorders, from painful to very painful complaints. The body parts complained of were the neck, shoulders, hands, back and legs. From the workers interviews, the result showed that they considered that muscular disorder was a common problem and can be solved by stretching the muscles.

3.2. HIRA identification

After knowing the worker's complaints, the next step was identifying the dangers in the furniture environment. It was known that there were 5 available sources of danger to identify whether there was a priority source of danger for repairing immediately. In Table 1. was explained about the work accidents risk assessment that occurred in the furniture making process.

Table 1. Risk Assessment

Process	Danger Description	The risk	Risk =L X S	Likelihood	Consequence	The Risk Category
Cutting	1. wood dust from cutting process	Respiratory allergy	4	4	1	Moderate risk
		Eye irritation	4	4	1	Moderate risk
	2. improper working position	Musle and back pain	15	5	3	Extreme Risk
Installing	1.bad material rrangement	Tripping overwork material	4	4	1	Moderate risk
	2. lack of supervision in laying down of the material and process	nail punture	6	3	2	Moderate risk
	3. improper working position	Muscle pain	15	5	3	Extreme
Finishing	1. chemical vapor	Respiratory disorder	4	4	1	Modrate risk
	2. Unergonomic working position	Muscle and back pain	15	5	3	Extreme

From Table 1. was known that there were sources of danger, such as wood dust from the cutting process, improper working position, bad material arrangements, lack of supervision in laying down the materials, and chemical vapors with 5 moderate risks, and 2 extreme risks category.

The extreme risk category was derived from the unergonomic working position source can causes muscle and back pain and related to the production process productivity. According to UNSW Health and Safety (2008) in Kurniawati's study, the risks which are classified as "Extreme" must get priority for improvement immediately. But, in this condition, all of the risks will be given the improvements but not based on priority.

3.3 RULA identification

RULA analysis was used to identify of worker's working position. Table 2. was result of risk factor survey assessment by using the RULA method

Table 2. RULA Analysis

No	Activity	Risk Category	Explanation
1	The first installing process 	High	The activity was a static activity or repetitive activity, squatting position but resting on 1 foot. The body and head were bent forward. So, its position must be fixed immediately.
2	The sanding by machine 	Moderate	The activity was static activity, the worker has to move the sanding machine continuously. The back position was bent forward, hand and legs positions were still in the normal condition, so it needs to be fixed as soon as possible
3	The cutting Process 	High	The activity was static activity. The back and neck were very high risk. The arms and wrists positions were too far from the body. So its positions must be fixed immediately

No	Activity	Risk Category	Explanation
4	The engraving process 	Small	The engraving process was static activity, the use of chair and the engraving machine placement can help the worker to minimize heavy loads around the back and legs, thus this condition was safe. Its position must be fixed as soon as possible
5	The manual engraving 	Small	The using of table can help the posture in the safe condition. The positions of back and neck were safe. The wrist and arms positions were located at 90° approximately. Its position must be fixed needed as soon as possible.
6	The staining process 	Small	The sitting position was low, thus it made body and neck little bit bend. The legs and hands positions were safe. It was needed to be fixed as soon as possible.
7	The second installing process 	Moderate	The worker was doing installing process by crouching barefoot, the body and neck positions were bent. The hands' position can cause fatigue due to repetitive activity. Thus, its conditions must be fixed needed soon

From Table 2. was known that 2 processes were classified as the high-risk category, 2 processes were classified as the moderate-risk category, and 3 processes were classified as the small-risk category.

3.4 OWAS Analysis

After the body posture analyzing by using RULA method, the next step was the OWAS analysis, which referred to Table 3.

Table 3. OWAS Analysis

No	Activity	Risk Category	Explanation
1	The first installing process	moderate	The attitude was dangerous for Musculoskeletal system, the working posture causing significant tension effect. It must be fixed needed.
2	The sanding with machine	moderate	The attitude was dangerous for Musculoskeletal system, the working posture causing significant tension effect. It must be fixed needed.
3	The cutting process	very high	The attitude was dangerous for Musculoskeletal system, the working posture causing clearly tension effect. It must be fixed needed now.
4	The engraving process	moderate	The attitude was dangerous for Musculoskeletal system, the working posture causing significant tension effect. It must be fixed needed.
5	The manual engraving	small	The attitude was no problem for musculoskeletal system. Thus, it was no need to must be fixed
6	The staining process	quite high	The attitude was dangerous for Musculoskeletal system, the working posture causing significant tension effect. It must be fixed needed soon.
7	The second installing process	moderate	The attitude was dangerous for Musculoskeletal system, the working posture causing significant tension effect. It must be fixed needed.

The results of OWAS analysis method were showed that the first installing, the sanding by machine, the engraving by machine, and the second installing processes were classified as the moderate-risk category, the staining process was classified as quite a high-risk category, the cutting process was classified as very high-risk category, and the manual engraving process was classified as low-risk category.

3.5 Recommendations for improvement

Recommendations for improvements were given to furniture based on the risk and working posture analysis, such as:

1. The best position improvement was done by finding scores combination based on RULA and OWAS analysis. In Table 4., the score simulation was recommended to get small risk result or minimize the improvement.

Table 4. RULA and OWAS analysis

Part of Body	score	Information
Upper Arm	2	Upper arm position
Lower Arm	3	The material work placement can be adjusted, so that the lower arm didn't form an angle more than 90°.
Wrist Twist and twist	1	The wrist score was affected by upper and lower arm position
Neck	2	The using of table can be equipment so that the neck position was not too bent
Trunk	1	The back position was not more than 20°, because it was causing back pain

2. According to Ageng's study (2012), the using of tools such as a small chair with a height of only 15 cm can help the worker position. Then, the recommendations of neck position were perpendicular with right and left shoulders and were designed so as not to bend to the side. [4]
3. According to Suhardi (2015) squatting position was allowed as long as it was not more than 2 hours.[11]
4. For improvement analysis by using the OWAS method was obtained score combination 1-1-2-1. It was referred to as the manual engraving process. Its position was classified as a small-risk category, thus It was cannot cause musculoskeletal disorder.
5. From the improvement analysis above, the next step was distributed NBM questionnaire to know the worker complaints. From NBM

questionnaire result was known that there were 7 out of 10 the worker who still got muscle pain in their back and neck. This number has decreased from the number of previous complaints.

4. Conclusion

The conclusions from this study were :

1. From the risk assessment result by using HIRA method were showed that there were sources of danger, such as wood dust from the cutting process result, improper working position, bad material arrangement, lack of supervision in laying down the material and chemical vapor were 5 moderate-risks category, and 2 extreme-risks category. The extreme-risk category was derived unergonomic working position so that it was can cause muscle and back pain which can be related to productivity of production process.
2. The NBM questionnaires before improvements were distributed to 10 furniture workers, and the result was showed that all of the furniture workers were getting muscle disorders, from painful to very painful complaints. The parts of the body are complained of being neck, shoulders, hands, back, and legs.
3. The RULA result was known that 2 processes were classified as high-risk categories, 2 processes were classified as moderate-risk categories, and 3 processes were classified as small-risk categories. The improvements were focused on the positions which have high-risk and it was must be fixed soon. From RULA analyzing, the improvement recommendations by using a chair can minimize squatting position and minimize the bent of back and neck position. Beside of that, the table can also be recommended to arrange the material for decreasing workload which is supported by upper and lower arms, and the wrist movements.
4. For improvements analyzing by using OWAS, it got score combinations such as 1-1-2-1 were upright body, both of hands under the shoulders, standing on 2 feet and the load was not more than 10 kg. These scores were referred to in the manual engraving process. Its position was classified as a small-risk category so that it didn't cause musculoskeletal disorder.
5. From the result of the NBM questionnaire was showed that there were 7 out of 10 the workers were still having muscle pain in their back and neck. These numbers were decreasing from the previous numbers. The decreasing of these complaints was inverse with the time of production process.

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The Development of Information Systems for Measuring Student Performance at MTs Al-Azhar Paseseh Tanjung Bumi

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A B S T R A C T

Education becomes a compulsive program set by the government by implementing a 12-year compulsory education to improve human resources in Indonesia. A part of primary education concerns and results from measurement of student performance, that we call it school report cards. The main aim of this research is to build a school grade information system to help teacher and the homeroom teacher in input school report cards. Development of this system has built by applying the waterfall model. Data obtain to making this system, we use two elicitation techniques, questionnaire and interview technique. The advantage of this system is that our system didn't need use online and all data will stored in a database and can print as a report.

Keywords: Education, Information System, Student Performance, Waterfall Model.

Article History
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1. Introduction

Education is one important aspect in improving the quality of a nation, and also benchmark of the progress of a nation. But mostly academic services school in Indonesia is input manually. One service is the management of student grades by each subject teacher input student grades into a paper or file then given to homeroom teacher. The homeroom teacher processing it to be a school report card.

On this case will have any of several problems, including

- A teacher who accidentally lost student test results or undermine the file.
- The homeroom teacher who received the file also made the same mistake.
- Homeroom student is mistaken or forgot where his student report cards are stored. It caused by cabinets who stored school report cards are not organized neatly, and the number of student report cards in one cupboard.
- students undermine school report cards or damaged school report cards given by the homeroom teacher.

Therefore, we need a solution to eliminate the problems by designing an information system that can support the processing of student test results quickly, accurately and efficiently.

Ministry of Education and Culture (Kemdikbud) has built an integrated report card system, called E-Rapor. E-Rapor is evaluating student learning outcomes, both by educators and by the Education unit that has been integrated with Basic Education Data (Dapodik). Implementing e-Raport is done in stages considering a large number of schools in Indonesia. The application is carried out at the junior high and high school levels especially in 2017 then followed by elementary schools that are planned to be implemented this year. Based on the above statement, it is possible that several schools in Indonesia experience several obstacles including:

- Less socialization or technical guidance (bimtek) regarding this e-Report on a school so that the process of evaluating student performance or learning is still done manually,
- internet connection where the school is located because e-Raport is used online
- because e-Raport is a system integrated with dapodik, only teachers who have NUPTK can fill the system. This becomes an obstacle for honorary teachers to enter grades because they do not have a NUPTK,
- the teacher's willingness to understand and use the e-Raport system.

Base on that problems, we built a student performance evaluation information system in helping the processing of student learning outcomes. The system that we built applies the waterfall model approach with a display that makes it easy for users who are not yet familiar with technology. The system we made is a desktop-based information system where there is no need for an internet connection to use. All data entered will be automatically stored in the database so that the data will be safe

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even if the data file is damaged. This system just need installation in every computer to process student data.

2. Methods

2.1. Collecting data

- Questioner

Questioner is a method to collecting information that allows analysis to observe the attitudes, conviction, behaviors, and characteristics of some people in the organization who can be affect by the proposed system or existing system

- Wawancara

On these methods, we conducting direct interview by ask some question to homeroom student about how they processing their student grade to be student information.

2.2. SDLC model

Basically, waterfall model containing 5 steps, there are : analitic, design, implementation, trials, and maintain [1, 2]. Winston W. Royce proposed the first waterfall model in 1970 which describes in practice software engineerin [3]. Waterfall model's stage seen on Figure 1.

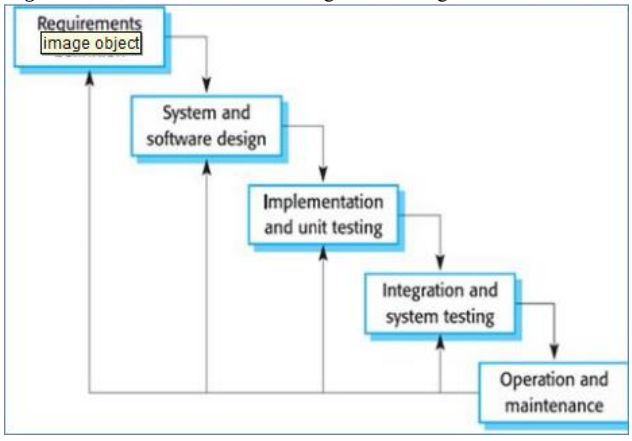

Figure 1. The Waterfall Model [4, 5]

- Analysist Stage : Initial stages of the waterfall model called software requirements specifications. In this stage produces 2 system requirements such as; functional requirements and non-functional requirements. We can interpret functional needs as features that owned by system being built. While non-functional requirements geting from several criteria including system limitations, reliability, scalability, testability, availability, maintainability, performance, and quality standards [1]
- Design Steps: Planning process and problems solving by defining plans be algorithm designs.
- Implementation Steps : Pouring requirement analysis and algorithm design into the programming language set by programmer. On this stage it also builds a database is also as a storage place for system input data.
- Trial Stage : In this stage, we finding errors that exist on the system that has been built. To maintain quality of system, we should carry a trial by a third party, where they have a relationship with customers and developers.
- Maintain Stage : modification on system process if needed. includesing system adaption to data environment of technological developments and changing base on customers requirement.

3. Hasil dan Pembahasan

We built this student performance measurement system to make processing of student grades became easier and faster to process for every student report card. User's just input score and attendance based on the category they need and system will automatically give an output in student report cards form.

3.1. Requirement

Requirement analysis of this system in which researchers conduct the elicitation process using observation and questionnaire techniques. Researcher conducting observation technique on score processing in the MTs Al-Azhar, while interview technique conducted by selecting some informant at MTs Al-Azhar including teachers and homeroom teachers. Based on these 2 techniques will be a result of functional requirements that seen in table 1.

Table 1. Kebutuhan fungsional.

Kode	Keterangan
KD1	User able to input student scores.
KD2	User able to input data student attendance.
KD3	User able to printing student report class.
KD4	User able to input data student.
KD5	User able to input data guru.
KD6	User able to input subject data.
KD7	User able to input data of classroom.
KD8	User able to input homeroom data
KD9	User able to input student score.
KD10	User able to input student attendance data.
KD11	System was built using Java programing

3.2. Design

On design stage, researchers using UML (Unified Modeling Language) design as a tool in making the design of this system. Java script and UML are excellent to abstract a system or software, that why we select them. OOP (Object Oriented Programming) most widely used by programmers is the java script programming. UML comprises 13 diagrams and divided into 3 categories groups. The division of categories of groups can be seen in Figure 2.

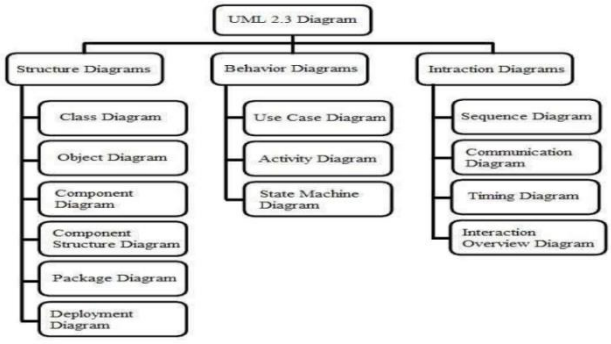

Figure 2. UML Diagram [6]

Based on 13 diagram variant jenis was labeled on UML, researcher using 2 diagram, that is use case diagram and class diagram during built this system. case diagram seen on figure 3.

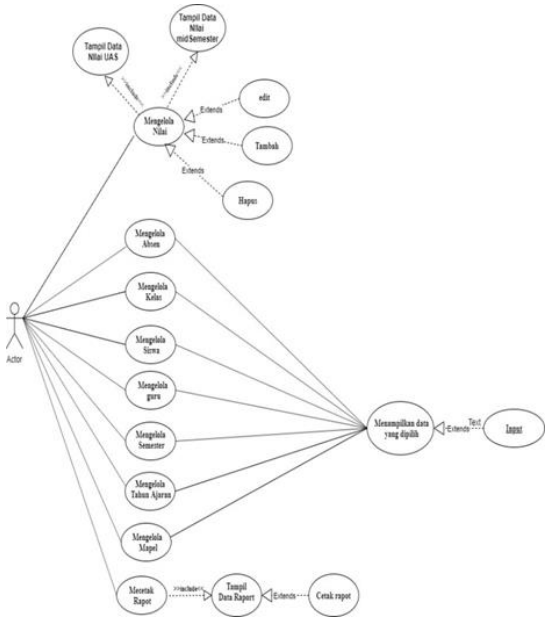

Figure 3. Use Case Diagram

In Figure 3 only available to one actor, the user. The user also acts as a system admin who has full access rights to the system. User able to manage values, manage absences, manage classes, manage students, manage teachers, manage homeroom teachers, manage subjects, and print reports. Print report in this case is student report card.

In addition to the use case diagram terable to also class diagram (able to be seen in Figure 4). Class diagrams are designed because they make it easy for programmers to convert designs into object-oriented programming languages. Class diagram illustrates the description and structure of classes, packages, and objects along with their relationships with one another.

In designing the database design the researchers described it in CDM and PDM. CDM and PDM make it easy for programmers to generate databases built into database management system software directly (My SQL, Oracle, etc.).

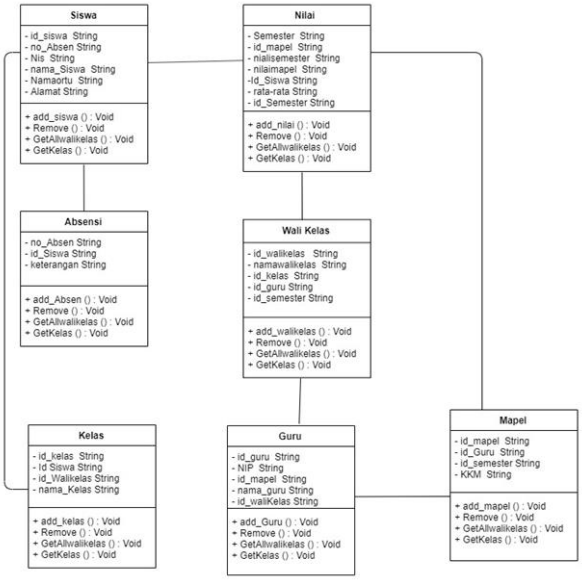

Figure 4. Class Diagram

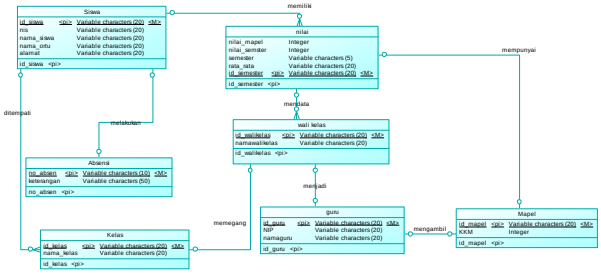

Figure 5. CDM

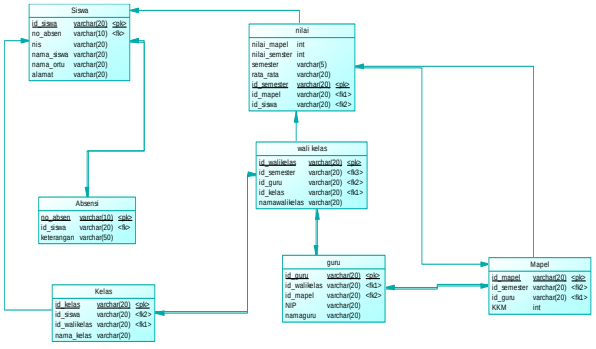

Figure 6. PDM

3.3. Implementation System

Development of student score measurement systems is divided into several forms including: homeroom form, teacher form, class form, student form, subject form, score form, presension form, and print report form.

(a) (b) (c) **(d)** (e) (f) (g) (h)

Figure 7. (a) homeroom form, **(b)** teacher form, **(c)** class form, **(d)** student form, **(e)** subject form, **(f)** score form, **(g)** presension form, and **(h)**print report form.

4. Kesimpulan

We have developed student performance measurement information system or using the waterfall model approach. The waterfall model has five main stages including system requirements, analysis, design, implementation, testing, maintenance. Besides these five stages, the other main process in the system development stage is the elicitation process, which is extracting data in search of we use whatever needs in building the system. The technique used in this study is the technique of distributing questionnaires and interview techniques.

With the approach we have used, users have been able to manage student performance in each class at Al-Azhar MTs. Teachers and homeroom teachers will have a student data bank and student grades stored in the system database and do not worry if they lose the manual file of student grades that they store manually..

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Design Project Management Application Of The Blind Color Test Android Based

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A B S T R A C T

IT project management is an activity of resources available from IT solution development projects that can produce a system solution that meets predetermined requirements. Developments in the era of technology are moving forward with the development of companies engaged in technology services. This project planning can be prepared using Work Breakdown Structure (WBS), budget plans and network diagrams (AON). The color blind test application system is an application to facilitate the detection of colors early on in someone and also provides accessibility to the black test. By managing a good project management, it is possible to estimate the time and cost needed in implementing the project, so as to minimize the estimated cost due to additional project delays.

Keywords: Project management, WBS, RAB, AON, android, java, color blind test.

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1. Introduction

Color blindness is a condition where a person cannot distinguish certain colors that can be distinguished by people with normal eyes. A person suffering from color blindness can be caused by abnormalities from birth or due to excessive use of drugs. Color blindness is commonly suffered by men, while women are only as a recessive gene.

Technological advances have generally led to increasingly sophisticated equipment in the fight against disease or make early detection in certain conditions. One of the developments in the advancement of medical science is color blindness using Ishihara's book. Color blind testing is currently very much needed for the industrial, educational, and government worlds. This is caused by human dependence on work or education which is closely related to color.

Ishihara's media with paper sheets has the disadvantages of color fading, tearing easily, and could be one of the test sheets tucked or lost. The automatic color blind testing instrument will try to replace the Ishihara test book which has been a guide for eye doctors.

Color in everyday life plays a big enough role. Many daily work is done by distinguishing the color of an object. But for people with color blindness, it must be difficult to distinguish certain colors. For that, we need a media that can facilitate people with color blindness in detecting the color of an object.

As we know, the development of technology in communication and data transfer is very rapid. One technological tool that is growing rapidly is a Smartphone. Almost every person in the world has handheld technology that is easy to carry everywhere and is lightweight. With the development of Smartphone technology, it also encourages the development of various applications that provide various features for human life.

2. Method

The research method used is starting from the discovery of the problem, determining the research objectives, data collection and processing. The steps undertaken for data processing are:

- Identify project activities using the Work Breakdown Structure (WBS) is simple.
- Making the flow of activities with precedence diagrams. To determine the time and cost of efficient project implementation, methods used in project management strategies are AON and RAB.

2.1. Ishihara Method

Ishihara test or Ishihara test is a test used to test the level of color perception in patients with red and green color blindness. Named the Ishihara test because it was discovered and designed by Dr. Shinobu Ishihara, a professor from the University of Tokyo in 1917. The Ishihara Test consists of several plates called Ishihara plates.

2.2 Work Breakdown Structure

Work breakdown structure (WBS) is a grouping of work elements shown in graphical form to organize and divide the overall scope of a work project (Rev, 2003).

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2.2. Activity on node (AON)

AON is an activity that is described on the node in this case the arrow (arrow) is a logical relationship between activities.

2.3. Cost Budgeting Plans

According to Sugeng Djojowirono, 1984, the Project Cost Budget (RAB) is an estimated cost needed for each work in a construction project so that the total costs needed to complete a project will be obtained.

2.4. HR Management Plan

In the opinion of Henry Simamora, human resources (HR) is the utilization, development, assessment, remuneration, and management of individual members of an organization or group of workers. So the design of human resource management is a design to regulate the utilization, development, appraisal, remuneration, and management of individual members of an organization or group of workers.

3. Result and Discussion

3.1. Design with WBS

Table 1. Design wit WBS

No.	Project Activity
1.	Opening
	1.1. Project planning
	1.2. Project description
2.	Planning
	2.1. Planning a needs analysis
3.	Implementation
	3.1. Planning a needs analysis
	3.1.1. Analyzing functional requirements
	3.1.2. Analyzing non-functional requirements
	3.1.2.1. Hardware requirements
	3.1.2.2. Software Requirement
	3.2. Analyze system requirements
	3.3. Scheduling planning
	3.4. Designing the system
	3.5 System Programming
	3.6. Documentation of the implementation
4.	Testing
	4.1. System Testing
5.	Closing
	5.1. Documentation
	5.2. Maintenance
	5.3. Support

3.2. Project Schedule

Table 2. Project Schedule

	ID	Project Activity	Duration	Start Date	Finish Date	predecessor
1.	A	Project design	4	01/11/2019	05/11/2019	none
2.	B	Project description	5	05/11/2019	11/11/2019	A
3.	C	Planning analysis	5	11/11/2019	16/11/2019	B
4.	D	Analyzing System requirements	11	16/11/2019	27/11/2019	B,C
5.	E	Analyzing Functional Needs	6	27/11/2019	03/12/2019	D
6.	F	Analyzing non-functional requirements	5	03/12/2019	08/12/2019	D,E
7.	G	Hardware requirements	4	08/11/2019	12/12/2019	E,F
8.	H	Software Requirement	4	12/12/2019	16/12/2019	E,F
9.	I	Scheduling scheduling	3	16/12/2019	19/12/2019	D
10.	J	System Designer	7	19/12/2019	26/12/2019	D,E,F
11.	K	System Programming	15	26/12/2019	10/01/2020	C,J
12	L	Documentation of the implementation	5	10/01/2020	15/01/2020	K
13	M	System Testing	4	15/01/2020	19/01/2020	L
14.	N	Documentation	5	19/01/2020	24/01/2020	M
15.	O	maintenance	5	24/01/2020	29/01/2020	N
16.	P	Support	4	29/01/2020	02/02/2020	O

3.3. Diagram AON

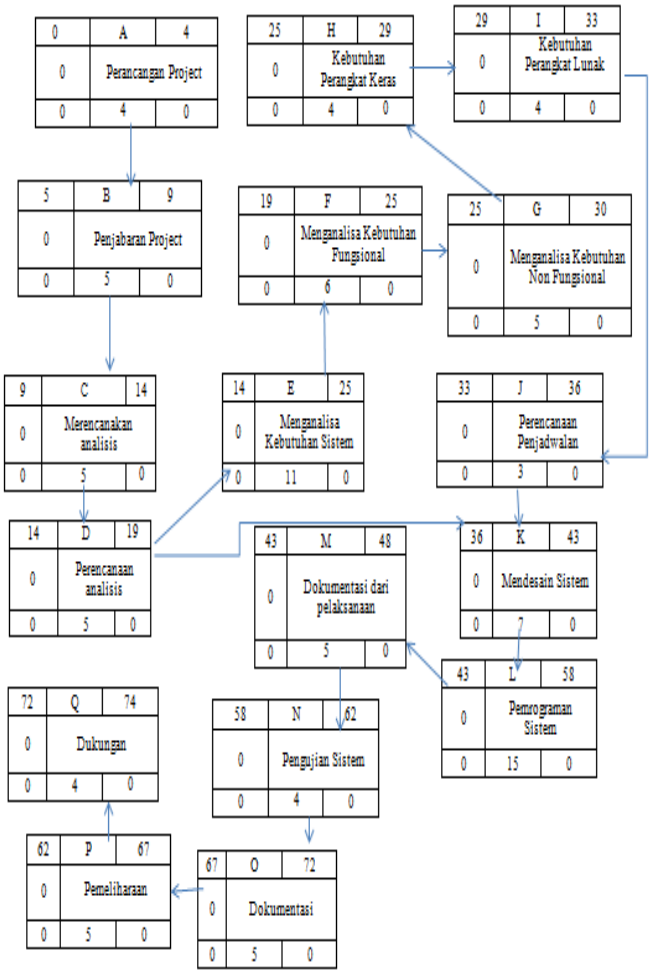


Figure 1. Diagram AON

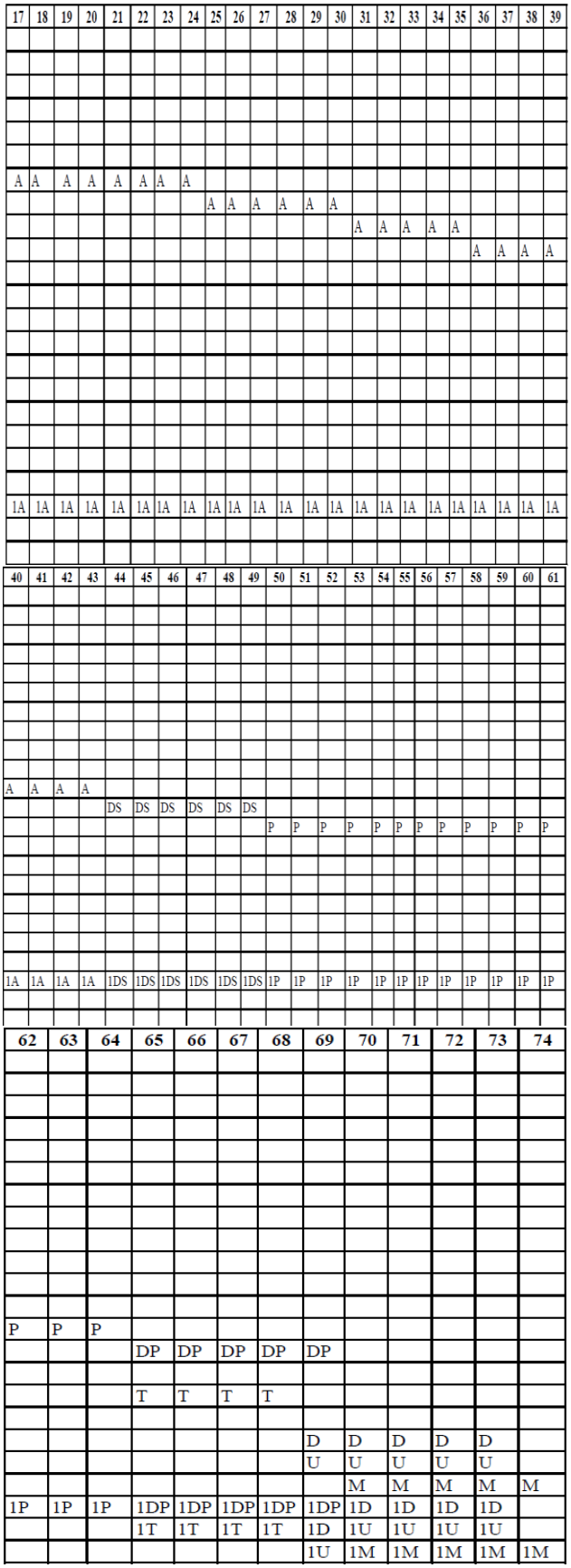
3.4. Shopping Budget Plan

Table 3. Shopping Budget Plan

No.	Project Activities	Duration (days)	Number of workers	Labor rates	Labor costs	Total cost
1.	**Opening**					
1.1.	Project design	4	1	1.000.000	4.000.000	4.000.000
1.2.	Project description	5	1	500.000	2.500.000	2.500.000
2.	**Planning**					
2.1.	Project description	5	1	500.000	2.500.000	2.500.000
3.	**Implementation**					
3.1.	Planning a needs analysis	5	1	500.000	2.500.000	2.500.000
3.2.	Analyze system requirements	11	1	700.000	7.700.000	7.700.000
3.1.1.	Analyzing functional requirements	6	1	500.000	3.000.000	3.000.000
3.1.2.	Analyzing non-functional requirements	5	1	500.000	2.500.000	2.500.000
3.1.2.1.	Hardware requirements	4	1	400.000	1.600.000	1.600.000
3.1.2.2.	Software Requirement	4	1	400.000	1.600.000	1.600.000
3.3.	Scheduling planning	3	1	500.000	1.500.000	1.500.000
3.4.	Designing the system	7	1	3.000.000	21.000.000	21.000.000
3.5.	System Programming	15	1	3.000.000	45.000.000	45.000.000
3.6.	Documentation of the implementation	5	1	3.000.000	15.000.000	15.000.000
4.	**Testing**					

3.5. HR Management Design

ID	RES	DUR	ES	LF	SL	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1																						
1.1	1A	4	0	4	0	A	A	A	A													
1.2	1A	5	5	9	0					A	A	A	A	A								
2																						
2.1	1A	5	9	14	0										A	A	A	A	A			
3																						
3.1	1A	11	14	19	0															A	A	A
3.2	1A	6	14	25	0																	
3.2.2.1	1A	5	25	30	0																	
3.2.2.2	1A	4	25	29	0																	
3.3	1A	4	29	33	0																	
3.4	1DS	7	33	36	0																	
3.5	1P	15	36	43	0																	
3.6	1DK	5	43	58	0																	
4																						
4.1	1T	4	58	62	0																	
5																						
5.1	1D	5	62	67	0																	
5.2	1U	5	67	72	0																	
5.3	1M	4	72	74	0																	
Total resource load						1A	1A	1A	1A	1A	1A	1A	1A	1A	1A	1A	1A	1A	1A	1A	1A	1A



3.6. Tools and Techniques Risk

The risk identification technique used is a SWOT analysis, namely:
1. Strengths:
- Facilitate project planning
- Provide the right solution for users
2. Weaknesses
- Very high costs
3. Opportunities
- Can provide high business opportunities
- Projects will be completed on time
4. Threats
- Data that is vulnerable to theft if there is no system security

Tools and Techniques used:
1. Documentation reviews, in the form of:
- Weekly report on project work
- Note the minutes of each project meeting
2. Information gathering techniques
3. Checklist analysis
4. Assumptions analysis
5. SWOT analysis
6. Expert judgment

Produce:
Risk register, which is a document contains the results of various risk management processes potential and related information.

3.7. Tools and Techniques Monitoring

Project monitoring is directly led by the project manager as the project leader, and in mrmonitoring focuses on controlling the work to keep it in accordance with the planner, effective use of existing resources and fixing if there are problems. Resources used are internal documents such as: monthly / weekly reports, minutes of minutes of meetings held.

4. Conclusion

The Development Success of this color blind application project can be seen from Having a clear definition of goals, in accordance with the objectives that have been explained previously. What is meant is how big the project will be implemented and what needs are needed by everyone involved in making the project. the project to make a color blind application will take 74 days and a total cost of Rp 217,100.00

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