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Composition Model of Organic Waste Raw Materials Image-Based to Obtain Charcoal Briquette Energy Potential

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Abstract—Indonesia needs new renewable energy as an alternative to fuel oil. The existence of organic waste is an opportunity to replace oil because it is renewable and contains relatively less air-polluting sulfur. Previous research that has been widely carried out still utilizes coconut shell raw materials, which are increasingly limited in number, so other alternative raw materials are needed. A model is needed to make a formulation that can optimize the composition of organic waste raw materials as a basic ingredient for making briquettes. The research objective was to determine the best raw material composition based on digital image analysis in processing organic waste into briquettes. An artificial intelligence approach with a Convolutional Neural Network (CNN) architecture can predict an effective object detection model. The image analysis results have shown an effective model in the raw material composition of 60% coconut, 20% wood, and 20% adhesive to produce quality biomass briquettes. Briquettes with a higher percentage of coconut will perform better in composition tests than mixed briquettes. The energy obtained from burning briquettes is useful for meeting household fuel needs and meeting micro, small, and medium business industries.

Keywords-Organic waste; raw material; composition; model; charcoal briquettes.

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I. INTRODUCTION

Indonesia needs new renewable energy as an alternative to fuel oil. Energy is needed to support human activities such as economy, households, industry, trade, the and transportation [1]. The need for new renewable energy to replace heating oil increases with the presence of organic waste in the surrounding environment [2]. The Director General of the Department of Mineral and Coal of the Ministry of Energy and Natural Resources (ESDM) said that Indonesia's coal reserves currently reach 38.84 billion tons (https://www.esdm.go.id/). The average coal production is 600 million tons annually, so the coal reserves are still around 65 years old, assuming no new reserves have been found. The condition of the limited amount of available fossil fuels encourages the government, the business world, and the public to use alternative energy for their daily fuel needs [1].

A strategic policy on new and renewable energy is needed to create national energy security and support the community's needs [3]. Until now, Indonesia has depended on non-renewable energy sources such as fuel oil extracted and refined from petroleum and used in areas of life such as transportation, industry, and households [4]. Alternative energy, such as briquettes, is needed to overcome the limitations of energy sources [5]. The organic waste is processed into briquettes so that the agricultural sector becomes strategic in meeting the needs of industry and society [6]. Energy derived from biomass briquettes can be an alternative energy source to replace fossil fuels (petroleum) because of its many advantages [7]. Organic waste can be used sustainably because it is renewable and relatively free of sulfur, does not cause air pollution, and can increase the use of forest and agricultural resources [8].

The quality of the briquettes is determined by the composition of the raw materials, especially organic waste such as coconut shells [9]. The amount of raw material for organic waste from coconut shells is quite large in the lives of Indonesian people [10]. It is necessary to test the available raw materials with certain combinations and recipes to determine the composition of good raw materials. There are different combinations to produce biomass briquettes. Briquette products require the right combination of charcoal briquette

products with a composition of 50% coconut coir and 50% coffee coir with a water content of 12.487% to a composition of 75% coconut coir and 25% coffee husks with a moisture content of 14.96% [11]. The two compounds' water content differs, which affects the quality of coal briquettes. Burning is better when the moisture content is lower [12], [13]. The highwater content in charcoal briquettes makes them difficult to burn because it produces smoke when burned, lower the calorific value and form mold. In addition to determining and assembling raw materials[14], it also includes compaction and drying of briquettes. The process has significant implications that require efforts to determine the composition of the raw materials suitable for biomass briquette processing [15], [16].

The problem formulation is based on designing the composition of organic waste that can produce alternative energy [17], [18]. This study aims to get the best recipe that optimizes the composition of organic waste raw materials as raw materials for making charcoal briquettes to produce quality products [19], [20]. The strategic goal is to help the government meet the availability of alternative energy sources to replace heating oil [21]. The main objective of this research is to meet the energy needs to support the life of businesses, households, industries, and public transportation. Artificial Intelligence is used to meet energy needs to become a knowledge base for making charcoal briquettes with specific raw material composition from organic waste [22], [23]. The process requirements for making charcoal briquettes must comply with the Indonesian National Standard (SNI). Determination of the combination and combination of raw materials affects the quality of the resulting briquettes [24].

Previous researchers have researched the processing of briquettes and the composition of raw materials. Researchers from various countries have carried out several studies, such as using walnut shells as a bio briquette material by making briquette dough utilizing a composition of 250g:50g 100 ml with a ratio of 100%, 50%:50%, and 75%:25%. The grain sizes used consist of 28 mesh, 65 mesh, and 80 mesh. Research yields the best shot with an 80 mesh to 50:50 ratio because it is strongest against heavy pressure [25].

A study on the effect of variations in the amount of tapiocagluten flour on the properties of coconut shell charcoal briquettes aims to determine the impact of variations in the amount of tapioca-gluten flour, on the properties of the resulting briquettes, including calorific value, moisture content, and brittleness index. They pressed 150 kg/cm² with varying amounts of tapioca flour and glue (5%, 7%, 9%). The briquettes were dried in the oven at 100 °C for 2 hours. Charcoal briquettes are cylindrical and 2.5 cm in diameter. The results showed that the best briquettes were used from a mixture of 7% with a calorific value of 7652.64 cal/g, a moisture content of 3.23%, and a sharp index of 0.18% [26].

A study to predict the performance of millet bran briquettes using Artificial Neural Network (ANN) methods can predict the performance of briquettes. This study uses experimental data to train, test, and validate artificial conditional networks. This method offers the advantage of being a guide to predict physical parameters effectively with the smallest deviation and high accuracy [27].

Research on manufacturing charcoal briquettes from coconut shells by the pyrolysis process provides an overview of the methodology used. The study used the two-barrel writing method, the wood crushing method, the 60-mesh screening method, and the weighing of $\pm 1/2$ ton briquettes with an adhesive composition variation of 5% by weight of charcoal powder. Namely 2g sago and 8g tapioca, 3g sago and 7g tapioca, 5g sago and 5g tapioca, 7g sago and 3g tapioca, 8g sago and 2g tapioca. The study results were optimal conditions for glue concentration in bamboo charcoal briquettes with 2g sago and 8g tapioca glue [28].

The chemical and physical properties of binder applications such as potato starch and Carboxymethyl Cellulose (CMC) at ratios of 5%, 10%, and 15% for briquetmaking purposes were already examined in the study. This study carried out the addition of 10% starch which showed better performance, while the addition of 10% CMC showed better performance in physical characteristics [24]. Researching how the raw material composition affects the calorific value of a mixture of carbonized walnut shells and bio-coal briquettes is beneficial. Walnut shells and charcoal are used to make bio-briquettes with the following ingredients: (250 g charcoal/walnut shell, 12.5 tapioca flour, and 50 ml water). Type IV Bio briquette research revealed a caloric value of 6,096 kcal/g [29].

In a study on briquettes, raw materials are used to produce briquettes from agricultural crop residues, industrial waste, garbage, sludge, or other plants as alternative fuels. Research demonstrates the nature of the raw materials used to produce briquettes to identify the best crop residues [30]. The milk products offered are organic dairy products created from organic raw materials. They contain bifidobacterial, vitamins, vital fatty acids, and a balanced ratio of fatty acids and amino acids. Research produces products such as the nutrition of people under high mental and physical stress and the prevention of many diseases [31].

In a muffle furnace operating at 850 °C for three hours, ash analysis of charcoal briquettes formed with mixed binder and ash from various briquettes was done. Charcoal briquettes are labeled as having harmful content. The study found that the charcoal ash formed by the briquettes was hardly affected by the addition of roasted biomass (10%) and mixed binder (15%) to coal [32].

Paraffin and non-paraffin Phase Change Materials (PCM) are the categories into which organic PCM are commonly divided. Organic PCM has a high when choosing which kind to utilize. Another benefit of organic PCM is that they will freeze without supercooling, unlike inorganic PCM, leading to a far more dependable system. Organic PCM does, however, have drawbacks as well. The high cost of production is one of these. They could be examined because they come from crude oil, a non-renewable resource. The considerable flammability of organic PCM severely restricts their use in the building industry because of the safety concerns associated with combustible materials.

The design of a model is needed to make a formulation that can optimize the composition of organic waste raw materials as a basic ingredient for making briquettes. The research objective was to determine the best raw material composition based on digital image analysis in processing organic waste into briquettes. An artificial intelligence approach with a Convolutional Neural Network (CNN) architecture can predict an effective model for detecting objects to increase the accuracy value. Previous research that has been widely carried out still utilizes coconut shell raw material, which is used as a material for processing biomass briquettes. In recent developments, the number of coconut shells has become increasingly limited, so alternative raw materials are needed. The composition formulation is very useful in supplying raw materials for organic waste available in the community.

The government, entrepreneurs, and the public need to create opportunities to use raw materials other than coconut shells which are often used because currently, the amount is very limited. Some opportunities for the availability of other sources of raw materials are sawdust, corn cobs, rice husks, and plant leaves with an Alexnet architecture in the CNN approach. Briquette fuel energy is used to meet the cooking and home industry needs. Briquette production is also needed to meet the export demand for biomass briquettes.

II. MATERIAL AND METHOD

A. Types of Research

Object detection is a type of applied research needed to provide solutions to raw material quality problems [33], [34]. An artificial intelligence approach is necessary to determine the composition and combination of raw materials for organic waste, which is expected to produce a predictive model [23], [35]

The selection of suitable raw materials largely determines product quality. The stages in the processing of charcoal briquettes begin when determining raw materials, crushing, mixing, printing, and drying into briquettes [36], [37]. Determination of the composition and combination of raw materials for organic waste is the initial basis for producing quality briquettes.

B. Method of Collecting Data

The data collection method used included literature studies by studying scientific articles about charcoal briquettes' mixture and composition and the process conditions carried out. After that, observations were made by observing the process of determining raw materials to make charcoal briquettes so that the input and output variables that would be used could be known. The selected variables are mass, the combination of briquettes, moisture content, drying temperature, duration of drying time (baking), and densification pressure. The data set was obtained through trials in making simple charcoal briquettes with several raw materials, such as coconut shells and sawdust.

C. Convolutional Neural Network (CNN)

In recent years, CNN has completely dominated computer vision. CNN consists of input, output, and several hidden layers. The hidden layer of a CNN usually consists of a convolutional layer, a pooling layer, a fully connected layer, and a normalization layer. CNN is designed to learn spatial hierarchies automatically and adaptively.

Convolutional neural network (CNN), a class of artificial neural networks that have become dominant in various computer vision tasks, is attracting interest across multiple domains, including briquettes research development. The CNN method is used to detect and recognize certain objects in an image and can also be used in facial recognition, document analysis, image classification, video classification, etc.



Fig. 1 CNN Model

D. Alexnet Architecture

The CNN architecture model from AlexNet has the workings of the AlexNet architecture, which is divided into

two-layer groups. The first layer comprises feature extraction, namely the convolution layer and pooling layer, and the second group is classification.



Fig. 2 AlexNet Model

The Alexnet architecture structure has an input image size of 227x227x3. Where the image size is 227x227, and 3 is RGB. Convolution layer 1 has 96 filters with an 11x11 kernel, stride [4 4] and "same" padding. And every convolution layer on alexnet uses ReLU activation.

E. Experimental Design and Steps

1) Data Preprocessing Design: Charcoal briquette images originating from production are used as data processed with a deep learning approach. The image taken compares the composition of the charcoal briquette product.

2) Composition of Data Retrieval: Research through the stages of data collection, processing, and classification. The data collection process is based on the combination ratio of briquette raw materials. The manufacture of charcoal briquettes carried out in this study used the standard composition of coconut shell and sawdust with starch adhesive [38] as follows.

TABLE I
BENCHMARK MODEL FOR COMPOSITION OF COCONUT SHELL AND WOOD
POWDER 1

Briquettes	Coconut Shell (volume)	Sawdust (volume)	Starch Adhesive (volume)
1	90%	0%	10%
2	75%	15%	10%
3	60%	30%	10%
4	45%	45%	10%

In the data collection process, efforts were made to compose briquettes with briquette raw materials, such as the standard composition of briquettes in dry leaves and sawdust with tapioca flour adhesive. Based on the benchmarks in Table 1, charcoal briquettes are composed as follows.

TABLE II
BENCHMARK MODEL FOR COMPOSITION OF COCONUT SHELL AND WOOD
POWDER 2

Briquettes	Coconut Shell (Volume)	Sawdust (Volume)	Starch Adhesive (Volume)
1	10%	80%	10%
2	20%	70%	10%
3	30%	60%	10%
4	40%	50%	10%
5	50%	40%	10%

Based on this composition, charcoal briquettes get products that match the composition in Table 2. After making the charcoal briquettes, take an image of the finished product.

F. Making Data Briquettes

Making charcoal briquettes starts with preparing the mixed ingredients and drying the briquettes. Manufactured based on materials, a combination of coconut shell raw materials and sawdust proportionally. The proposed manufacture of briquettes is based on a combination of materials with a composition of 60% wood, 20% coconut, 20% adhesive, 60% coconut 20% wood, and 20% adhesive.



G. Design and Image Capture

The design includes classification stages: taking pictures, cropping photos, pre-processing data, training data, output

classification models, and the Briquette Classification Code. Taking pictures using a canon camera with the image resolution obtained is 5184x3456 pixels. The background used is white.



Fig. 4 Image capture



Fig. 5 Image Cropping

Cropping photos was conducted using the Photoshop application. This application makes it easier to crop images because there is an action feature where this feature can record the actions taken by the user, and then these actions are given to the next image. Use the action feature to cut images of the same size to get consistent data, namely 2250x1900 pixels.

H. Classification Method

The method for classifying biomass briquette products from image processing uses the Convolutional Neural Network (CNN) algorithm. Classification stages include taking pictures, cropping photos, pre-processing data, training data, output model classification, and charcoal briquettes classification program application.

III. RESULT AND DISCUSSION

A. Requirement Gathering and Analysis

Analytical studies are carried out through basic research based on practical facts and scientific application and development. An analytical study is basic research in dealing with real life to maximize the results of a better and more effective composition of organic waste raw materials. Analysis studies require the process of collecting, processing, and classifying data. Based on references or prior studies, the combination ratio of organic waste raw materials is used to gather data. The necessary and high-quality briquettes can be created by combining different raw material compositions.

B. Pre-Processing Data

Pre-processing of the data is done so that the training data is more consistent, and the resulting program is more precise. Resizing the image size reduces the computer's workload when training programs and data augmentation is useful for getting more data variations.



Fig. 6 Pre Processing Data

C. Training Data

During data training, pre-processing is done first on the data entered so that the data has a consistent value, and the training results can have a higher accuracy value. This training stage goes through several layers, namely the convolution layer, where the input image is represented as a 2-dimensional matrix. The following process is through the pooling layer. The type of pooling used is average pooling, to take the average value of the matrix area and combine it into one matrix with a smaller size.

The flattening process is carried out where the 2dimensional matrix generated by the pooling layer is converted into a single row array. It proceeds to the fully connected layer data stage. It has been processed in flattened and trained with a convolutional neural network algorithm.

The training process includes a feed-forward stage to determine the value of the resulting neuron that approaches the target with the minimum possible error. The training results produce weight and bias values used to classify data.



Fig. 7 Training Data

D. Testing Data

The results of the flattening process from the test data will go through a classification process to check whether the data has been trained. After checking, the results of the flattening process on the test data will be classified using a feed-forward.



E. Classification Output Model

After the data has been trained using tensorflow lite, the model is converted based on the data. It has been trained into a lighter and easier to use model.



Fig. 9 Classification Model Outputs

F. Briquettes Classification Program

Researchers created the briquettes classification program through a web display. The user will enter images then the model that has been made will read the images that have been entered and classify them based on class, and provide output in the form of classification results and variables from the briquettes image.



Fig. 10 Briquettes Classification Program

G. Libraries Call

Library call scripts based on machine learning capabilities. In the program section, data_dir is a directory included in a variable, so that directory writing is not done repeatedly but simply by calling the data_dir variable. Categories are class divisions for classifying data to be trained. For path variables, use os.path.join, which is useful for calling directory variables created to get files from directories. cv2.imread is used to load images in file directories, and plt.imshow is part of the matplotlib.pylot library, which is used to display images loaded by cv2.imread. The matplotlib displays the following image.pylot library.



Fig. 11 Matplotlib.pylot Library Script

The following image contains coordinates 0-2500 which indicate each pixel displayed.



Fig. 12 Briquettes Classification Program

The batch_size variable defines the number of samples in 1 batch. Each batch size is useful for separating the samples into one batch to reduce the computer workload. Batch size is the number of training data examples in one batch. The image size changed to 1300x1300 pixels. The image size is as large as possible because the object to be photographed has a texture. Therefore, the object's texture is then compared so that it can be classified.

<pre>train_ds = tf.keras.utils.image_dataset_from_directory(data_dir, validation_split=0.2, subset="training",</pre>	batch_size = 16 img_height = 1300 img_width = 1300
seed=123, image_size=(img_height, img_width), batch_size=batch_size)	Found 901 files belonging to 2 classes. Using 180 files for validation.
F: 12 GI	

Fig. 13 Classes Validation Script

The following is the program code that shows the amount of validated data.

class_names = train_ds.class_names print(class_names)	<pre>plt.figure(figsize=(10, 10)) for images, labels in train ds.take(1);</pre>	
['60kayu20kelapa20perekat', '60kelapa20kayu20perekat']	<pre>for i in range(4): ax = plt.subplot(2, 2, i + 1) plt.imshow(images[i].numpy().astype("uint%")))</pre>	
	plt.title(class names[labels[i]])	

Fig. 14 Class Names Script

The class shown will be classified between 60% wood, 20% coconut shell, and 20% adhesive compared to 60% coconut shell, 20% wood, and 20% adhesive.



Fig. 15 Composition Classification Data

The visualized data is then passed on to Keras Model.fit. The image_batch variable is a tensor of the form (16, 1300, 1300, 3). This is a collection of 16 images with the shape of 1300x1300x3 (the last dimension, i.e., 3 refers to RGB). Labels_batch is a form of tensor (16,), which corresponds to 16 images in a batch size.



Fig. 16 Image Train Script

H. Training dan Validation Accuracy

The img_to_array function converts the supplied images into an array. The expand_dims function is used to enter additional dimensions in the entered image array. The dimensions of the images that have been converted to an array are added to (1, 1300, 1300, 3). The number 1, which is the dimension, is added to the tensor.

One epoch is all data in the dataset entered into the neural network once. In one epoch there are several iterations where the number of batches needed to reach one epoch. Batch size is the number of data points in one batch, which is useful for calculating iterations with the formulation: iteration = total data/batch size.

The training data is 721, and the batch size is set to 16. Iteration results = 721/16 = 45.0625. When the program is trained, iterations show 46 because more images are counted in one iteration. The term "loss" refers to training loss, where the loss function of the training dataset and model predictions are used to generate the value.

When data is trained, accuracy refers to the computation of the correctness of the dataset and the model's predictions. Validation loss is the difference between predictions made by the model using data from the validation dataset as input and the predicted value of the loss function from the validation dataset. Moreover, validation accuracy results from computing the models prediction accuracy using the validation dataset's input data.

acc = history.history['accuracy']	briket = r"E:\\Briquette\60wood20coconut20adhesive \IMG 9.JPG"
val acc = history history ['val accuracy']	directory - os.path.join (briket)
	img = tf.keras.utils.load_img(
loss = history history['loss']	directory, target_size"(img_height, img_width)
val loss = history.history['val loss'])
	img array = tf keras utils img to array(img)
epochs range = range(epochs)	img array = tf.expand dims(img array, 0) # Create a batch
	predictions = model.predict(img_array)
plt.figure(figsize=(8, 8))	score - tf.nn.softmax(predictions[0])
plt.subplot(1, 2, 1)	print(
plt.plot(epochs_range, acc, label='Training Accuracy')	"This image most likely belongs to {} with a {:.2f} percent
plt.plot(epochs_range, val_acc, label='Validation Accuracy')	confidence."
plt.legend(loc='lower right')	.format(class_names[np.argmax(score)], 100 * np.max(score))
plt.title('Training and Validation Accuracy'))
plt.subplot(1, 2, 2)	epochs=5
plt.plot(epochs range, loss, label='Training Loss')	history = model.fit(
plt.plot(epochs range, val loss, label='Validation Loss')	train ds,
plt.legend(loc='upper right')	validation data=val ds,
plt.title('Training and Validation Loss')	epochs=epochs
plt.show())

Fig. 17 Accuracy Script

The program shows training and validation graphs of accuracy and loss values based on the matplotlib.pylot function with status Epoch five before and after augmentation. Measurement through the program has provided information and an overview of the effectiveness of using the augmentation method effectively. The test results with the standard architecture before and after the augmentation process have shown an accuracy value of 97.3%, as shown in Figures 18 and 19 below.



Based on the graph, it can be seen a decrease in the line before and after the augmentation. Therefore, the prediction process becomes better and approaches a highly accurate value.



Fig. 20 Image Visualization After Augmentation

I. Briquette Quality Measurement

Measurements were made on preparing the composition and combination of raw materials. Measurements refer to SNI quality standards (factory briquettes) with provisions in the form of temperature, burning duration, specific gravity before burning, specific gravity after burning and the remaining ash produced. Tests were carried out on each of 5 (five) samples of briquettes from the results of the raw material composition.

1) Factory Briquettes (90% coconut shell, 10% adhesive)

TABLE III COMPOSITION BRIOUETTE MEASUREMENT RESULTS FACTORY

Sample	Temp. (°C)	Duration (h:m)	Weight Before Burning (gram)	Weight After Burning (gram)	Ash Content (%)
1	424.3	2:50	13.3	0.9	0.067
2	514.3	2:38	14.0	1.2	0.085
3	459.4	2:40	13.2	1.3	0.098
4	487.7	2:32	12.7	0.9	0.070
5	495.4	2:40	13.2	1.0	0.075

2)	Artificial	Briquettes	(60%	coconut	shell,	20%	wood,
20% a	dhesive)						

TABLE IV
COMPOSITION BRIQUETTE MEASUREMENT RESULTS 60 20 20

Sample	Temp. (°C)	Duration (h:m)	Weight Before Burning (gram)	Weight After Burning (gram)	Ash Content (%)
1	438.5	1:38	8.3	1.3	0.156
2	434.1	1:23	7.5	0.9	0.120
3	455.5	1:24	7.4	0.7	0.094
4	443.4	1:32	7.9	0.6	0.075
5	436.7	1:23	7.0	0.7	0.100

3) Artificial Briquettes (20% coconut shell, 60% wood, 20% adhesive)

TABLE V Composition briquette measurement results in 20 60 20 $\,$

Sample	Temp. (°C)	Duration (h:m)	Weight Before Burning (gram)	Weight After Burning (gram)	Ash Content (%)	
1	435.4	1:14	4.8	0.8	0.167	
2	457.0	1:21	5.0	1.2	0.240	

Sample	Temp. (°C)	Duration (h:m)	Weight Before Burning (gram)	Weight After Burning (gram)	Ash Content (%)
3	434.6	1:22	4.7	0.9	0.191
4	446.2	1:17	4.9	1.0	0.204
5	445.5	1:23	4.8	1.1	0.215

The results of measurements of factory (Processing Factory CV Lebu Berkah Jaya at Bantul Yogyakarta) briquettes 90:10 with artificial briquettes 60:20:20 and artificial briquettes 20:60:20 can be concluded as follows.

 TABLE VI

 COMPARISON OF MEASUREMENT RESULTS

No	Parameter	Factory Briquettes 90:10	Artificial Briquettes 60:20:20	Artificial Briquettes 20:60:20
1	Temperature (°C)	576.22	441.64	443.74
2	Duration (h:m:s)	2:40:00	1:28:00	1:19:30
3	Weight before burning	66.40	7.62	4,82
4	Weight after burning	1.06	0.84	1.00
5	Ash content	0.079%	0.109%	0.203%

The test results show that the factory briquettes are higher in measuring temperature, duration, and weight before and after burning. The remaining ash indicates the smallest, which is very good in use. However, the resulting composition and combination of briquettes can also be used for fuel. This good energy potential can be used as an alternative fuel with a mixture of coconut shells and sawdust which are widely available in all regions of Indonesia. Comparison in measuring the quality of briquettes showed that factory briquettes were far better than artificial briquettes. On average testing five samples of raw materials based on composition and combination, there is still an opportunity to be used as an alternative to briquettes with the quality close to the factory.

J. Briquette Quality Color Measurement

1) Factory Briquettes (90% coconut shell, 10% adhesive): RGB value on briquette composition 1 (96, 88, 103), 2 (52, 47, 56), 3 (167, 164, 185), 4 (30, 27, 34), dan 5 (248, 242, 254). The blackest color of RGB from the composition of the briquette is 4 (30, 27, 34).



Fig. 21 Briquette Color 90-10

 Artificial Briquettes (60% coconut shell, 20% wood, 20% adhesive): RGB value on briquette composition 1 (148, 156, 152), 2 (199, 208, 208), 3 (232, 238, 239), 4 (66, 68, 67), 5 (37, 38, 39). The blackest color of RGB from the composition of the briquette is 3 (37, 38, 39).



Fig. 22 Briquette Color 60-20-20

3) Artificial Briquettes (20% coconut shell, 60% wood, 20% adhesive): RGB value on briquette composition 1 (197, 209, 210), 2 (110, 115, 109), 3 (43, 46, 49), 4 (245, 254, 255),

5 (58, 61, 64). The blackest color of RGB from the composition of the briquette is 3 (43, 46, 49).



Fig. 23 Briquette Color 20-60-20

The details of the composition of briquettes based on RGB value is shown in the following graph.



Fig. 24 Color Composition of all Briquettes

The image of the color composition of the briquettes shows the values distributed based on the proximity of the RGB colors. This color model defines three colors, namely Red, Green, and Blue which are added in various ways to produce various colors.

Based on the RGB value issued, the briquette image with the blackest color value is good for briquette 4 (90-10) with RGB values (30, 27, 34).

K. Comparison with AlexNet Architecture

Implementing the AlexNet architecture does not yield better training results than the standard architecture. This architecture only gets about 51% accuracy for its testing data shown in Figure 26.

The results of testing the model that has been trained using the AlexNet architecture get the highest score for an accuracy of 74.71% shown in Figure 27.



Fig. 25 Comparison of the Color Composition of the Briquettes



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Fig. 27 Accuracy and Loss After AlexNet Augmentation

L. Energy Potential Briquettes

The energy potential that can be obtained from processing organic raw materials into briquettes is quite large. There are many raw materials for coconut shells and sawdust in Indonesia, so they can be good new renewable energy sources. Utilization of these raw materials is still relatively less than optimal because they have yet to be seriously processed to become a biomass briquette product.

According to Indonesian Statistics Center data, Indonesia's population in 2021 will be 272.6 million. Use of household fuel briquettes 0.39 tons. Exports of briquettes to foreign countries such as China in 2021 amount to 196,243,000 tons. Based on these data, there are opportunities for processing raw materials into briquettes. The government and the community need to make maximum efforts to meet the demand for briquettes as a substitute fuel for oil and gas energy which are very limited in number.

Developing a raw material composition model is useful so that the available organic raw material sources can be utilized effectively for the availability of briquettes as energy potential. Households, including micro, small, and medium enterprises, can use briquettes to meet fuel. The study's results with the size of the cube of briquettes 2.5 cm and the composition of 60% coconut, 20% wood, and 20% adhesive obtained a temperature of 441.64 °C for 1 hour 28 minutes. There is an opportunity to use briquettes with this composition at a higher temperature.

IV. CONCLUSIONS

The results of the system design show that there is an effective model in the raw material composition of 60% coconut, 20% wood, and 20% adhesive to produce quality biomass briquettes with the blackest color of RGB from the composition of the briquette 3 (37, 38, 39). Briquettes with a

higher percentage of coconut will perform better in composition tests than mixed briquettes. The assessment of the color of the briquette image produced superior combustion outcomes and a more dominating black color.

Implementing the AlexNet architecture does not yield better training results than the general standard architecture. The potential for alternative energy can be obtained from material tests on the composition and combination of raw materials derived from organic waste, such as sawdust, commonly found around people's lives. The energy obtained from burning briquettes is useful for meeting household fuel needs and meeting micro, small, and medium business industries.

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