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# Briquettes from a Mixture of Cow Menure, Rice Husks and Wood Dust as Alternative Fuel

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## ABSTRACT

There is a lot of promise for the creation of briquettes made of wood dust, rice husks, and cow menure as alternative fuels. The water content (%) and ash content (%) was measured in this study. Carbon ratio (%), value calorific (cal/g), briquettes' percentage of volatile content and their compressive strength (g/cm$^2$). A financial feasibility analysis of briquettes was also conducted as part of this study. Sample 1 briquettes had a water content of 16%, whereas sample 2 briquettes had a water content of 12%. Because the results of this water content test range between 5% and 20%, they are still considered acceptable. According to the test results, sample 1 had an ash level of 33% and sample 2 had an ash value of 29%. There were 65% and 60% of flying chemicals in sample 1 and sample 2, respectively. The quality of the briquettes increases with decreasing volatile matter content. From the test results, sample 1 of the briquettes has a carbon level of 2%, whereas sample 2 has an 11% carbon content. Because carbon concentration affects the calorific value, it is a measure of fuel quality. Sample 1's briquette density is 0.539 g/cm$^3$, whereas sample 2's briquette density is 0.337 g/cm$^3$. Briquettes for sample 1 have a compressive strength of 13.26 g/cm$^2$, whereas sample 2 has a compressive strength of 15.3 g/cm$^2$. Overall, the briquettes' financial feasibility study is really promising, with a favorable net present value (NPV) of 144.074.566, a high internal rate of return (IRR) of 72.154%, a respectable net B/C of 4.37, and a comparatively short payback period (PBP) of 3.22 years. This indicates the value of continuing this project. It is believed that by using these briquettes, the amount of deforestation would decline and the dependence on firewood will decrease. We may protect biodiversity and ecosystems by protecting forests.

**Keywords:** wood dust, briquettes, rice husks, cow manure.

## INTRODUCTION

There is a lot of promise to produce briquettes from wood dust, rice husks, and cow menure as an alternative fuel (Waheed et al., 2023), particularly in nations with plentiful natural resources and rising energy demands like Indonesia. Indonesia has an abundance of materials, including wood dust, rice husks, and cow menure. Utilizing locally produced raw materials can boost the local economy and reduce the dependency on fuel imports.

In addition to producing useful energy, using cow menure as a raw material can help reduce the problem of animal waste. Because the raw materials may be renewed naturally, the briquettes that are produced can serve as a renewable energy source (Agustiar et al., 2023). Briquettes made from cow menure can contribute to energy source diversification, which is a critical step in lowering reliance on fossil fuels.

Briquettes containing a mixture of wood dust, rice husks, and cow menure have the capacity to generate large amounts of thermal energy. These briquettes may be burned to produce heat quite successfully. Briquettes made from a blend of wood dust, rice husks, and cow menure are a good alternative fuel for small-scale businesses, small industries, and household needs (Kidmo et al., 2021; Tamba, 2017). Furthermore, the growth of this mixture's briquette manufacture might open new business prospects, particularly in rural or agricultural areas. Participating in the briquette production value chain may help ranchers, farmers, and wood industry workers earn more money and minimize their reliance on fossil fuels.

Biomass is a group of non-fossil materials (Cao et al., 2020) that holds a lot of promise as an alternative energy source in Indonesia. Although there is a lot of it, its utilization has not been maximized. Antwi-Boasiako & Acheampong (2016) and Yank et al. (2016) have noted that certain biomass has a significant amount of potential. Waste from cow menure has the potential to be utilized as biomass for bio-briquettes (Dyah Radityaningrum & Yossy Harnawan, 2022). Briquettes' physical and chemical properties are typically used to assess their quality. To enhance their qualities, a few research have been conducted on mixed briquettes made from sawdust and various agricultural biomasses (Adu-Poku et al., 2022; Akolgo et al., 2021; Akpenpuun et al., 2020; Falemara et al., 2018; Noah et al., 2019; Ofori & Akoto, 2020; Vyas et al., 2015).

Due to the simple technique and technology used, the development of bio-briquettes may be carried out on a large scale. Agricultural waste and cow menure may be used to make bio-briquette material. The kind and composition of the raw materials as well as the briquette-making procedure affect the final product's quality.

## MATERIALS AND METHODS

### Materials

The main components used in this study are dried cow menure combined with rice husks, wood dust, and tapioca flour to act as a binder. Two runs of the experiment were conducted, with a comparison of the compositions as indicated in Table 1. The briquette molding tool model utilized in this research is a basic tool that uses a pump block molding machine with a capacity of 200 pieces per day and two molds for one push, each measuring 20 cm in length. The tool is used to print a mixture of cow menure, rice husks, and wood dust. Each mold is 10 cm in width and 16 cm in height. Figure 1 depicts the molder model.

**Table 1.** Basic material comparison for briquettes

| Basic material | Comparison of composition (%) | |
|---|---|---|
| | Sample 1 | Sample 2 |
| Cow menure | 77 | 74 |
| Rice husk | 10 | 5 |
| Wood dust | 0 | 9 |
| Tapioca flour | 1 | 1 |
| Water | 12 | 11 |

**Figure 1.** Simple briquette molder

**Method**

In order to reduce the amount of water in the cow menure, it is first dried in the sun for three days before being processed into biomass briquettes. After that, wood dust, rice husks, and dried cow menure are combined. Tapioca flour is used as a binding agent. Two runs of the experiment were conducted, with a comparison of the compositions as indicated in Table 1. The briquette mixture is combined with the binder and then pushed using a push-block molding technique within the mold. After molded, the samples are left to cure in the blazing sun for 20 days, or until the briquettes are entirely dry.

Proximate analysis is used in a few tests to determine the briquettes' quality after they have dried (Akhator et al., 2023). The water content (%), ash content (%), volatile compounds (%), and fixed carbon (%) of briquettes (Waheed et al., 2022) combined with rice husks, wood dust, and cow menure were all measured using proximate analysis. A bomb calorimeter was used to assess the calorific value (calories/gram), aside from that.

- Water content, Eq. (1):

$$\%MC = \frac{md}{ms} \text{ x } 100\% \quad (1)$$

where: $md$ – change in mass of sample, $ms$ – initial mass of sample (g).

- Ash content, Eq. (2):

$$\%\text{Ash} = \frac{ma}{md} \text{ x } 100\% \quad (2)$$

- Percentage volatile, Eq. (3):

$$\%VM = \frac{md - mc}{md} \text{ x } 100\% \quad (3)$$

where: $md$ – change in mass of sample after oven drying, $mc$ – mass of sample after heating in the furnace.

- Percentage fixed carbon, Eq. (4)

$$\%FC = 100\% - (\%VM + \%\text{ Ash}) \quad (4)$$

- Density, Eq. (5):

$$K = \frac{G}{V} \quad (5)$$

where: $K$ – density (g/cm$^3$), $G$ – dry weight (g), $V$ – volume (cm$^3$).

Briquette density is determined by first weighing the dry briquettes and then estimating their volume based on their form. The briquettes used in this study were made in the shape of rectangular.

- Financial feasibility analysis of briquettes, Eq. (6):

$$\text{NPV} = \sum_{t=0} \frac{Bt}{(1+i)^t} - \sum_{t=0}^{n} \frac{Ct}{(1+i)^t} = \sum_{t=0}^{n} \frac{Bt - Ct}{(1+i)^t} \quad (6)$$

where: $Bt$ – gross social benefits of the project in year $t$, which consists of all types of non-financial revenues or benefits received in year $t$; $Ct$ – gross social costs in year $t$, all types of expenditure, both capital and routine.

The following are the decision guidelines for the NPV assessment: (a) if the NPV is greater than zero, the project is feasible or acceptable to perform since it may bring benefits, the project is at the break event point (BEP), total revenue equals total expenditure; (b) NPV = 0 (zero) indicates that the project returns exactly the amount of social opportunity capital factor; (c) if NPV < 0 (zero), the project is not worth working on because it does not produce results worth the costs incurred; therefore, the project must be rejected.

$$Net\ B/C\ ratio = \frac{\sum PVnetBenefitpositif}{\sum PVnetBenefitnegatif} \quad (7)$$

The comparison of the amount of positive net present value (NPV) and negative net present value (NPV) is known as the Net benefit cost ratio, or Net B/C. The ratio of net benefit to cost provides an estimate of the number of times the benefit will outweigh the expense [1]. Net B/C = 1 indicates that the project is possible and that the revenue from the business is equal to the expenditures incurred. If Net B/C < 1 indicates that the project is not worth attempting, then the business is worth pursuing.

$$IRR = \text{i} + \frac{\text{NPV}_1}{(\text{NPV}_1 - \text{NPV}_2)} x\ (i_2 - i_1) \ldots. \quad (8)$$

where: $i_1$ – level of discount rate that produces NPV$_1$, $i_2$ – level of discount rate that produces NPV$_2$.

$$Pay\ Back\ Period = \frac{\sum_{i=1}^{n} \bar{\text{I}}_i - \sum_{i=1}^{n} \bar{B}_{icp-1}}{\bar{\text{B}}_p} \quad (9)$$

where: $cp$-1 – the year before pay back period, $I$ – the amount of investment that has been discounted, $B_{icp-1}$ – the number of benefits that have been discounted before pay back period, $B_p$ – number of benefits in the pay back period.

The flow diagram in this research is as shown in Figure 2.

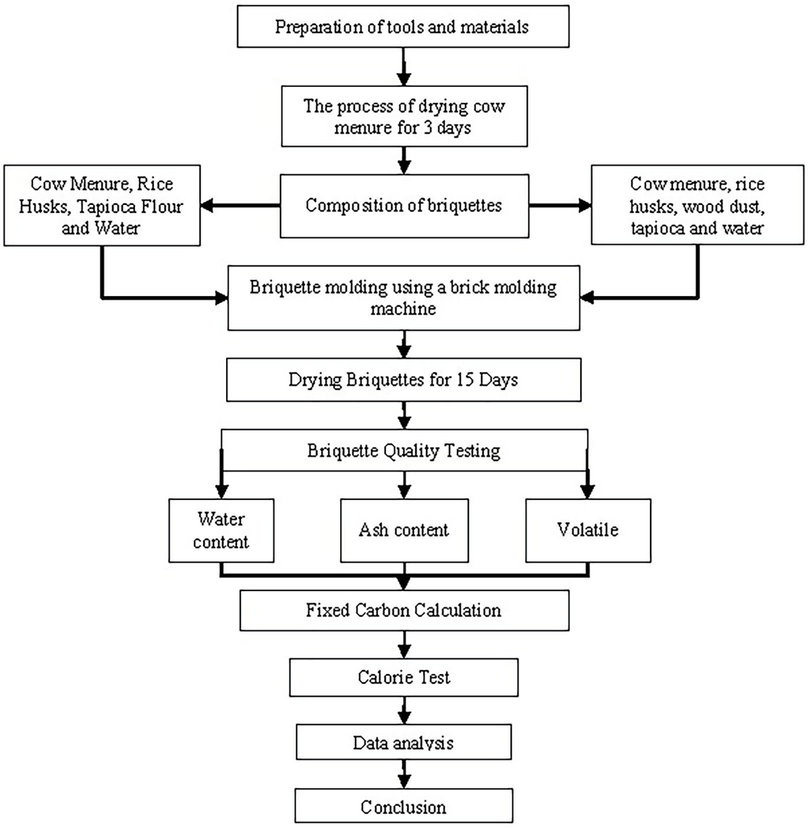


**Figure 2.** Research flow chart

## RESULTS AND DISCUSSION

The product of this study is briquettes combined with wood dust, rice husks, and cow menure. The carbonization process reduces the bulk of briquette sample 1 from 2312 grams to 1170 grams and sample 2410 to 731 grams. Figure 3 illustrates the color variations in briquettes that have been dried for 20 days. The product's dimensions 20×10×12.5 cm are displayed in Figure 4. The average density of dry briquettes was determined by adding the data from mass and dimension measurements. This resulted in a value of 0.337 g/cm$^3$.

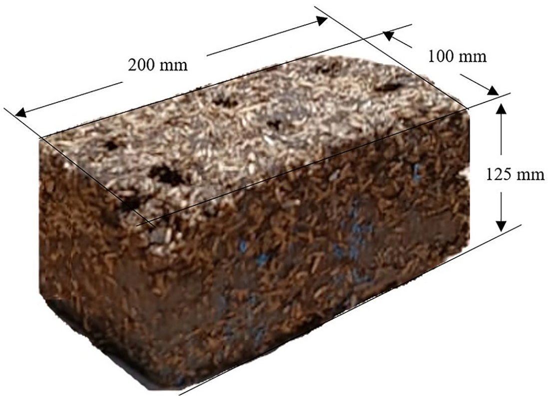


**Figure 3.** Briquette product dimensions

**Figure 4.** Difference in color of wet briquettes and dry briquettes

### Briquette quality

Table 2 shows the test findings for the volatile matter content, heating value, ash content, and carbon content. The purpose of conducting moisture content testing on briquettes is to determine the water content present in the briquettes. The moisture content in briquettes will affect the calorific value of the briquettes, thus influencing combustion and ash content in the briquettes. To get a high calorific value and create briquettes that are initially simple to ignite or burn, the water content of the briquettes should be as low as feasible. The higher the calorific value and combustion power, the lower the water content. On the other hand, briquettes with a highwater content will result in a decrease in the calorific value that they create. Sample 1 briquettes had a water content of 16%, whereas sample 2 briquettes had a water content of 12%. The findings of this study support those of (Olorunnisola, 2007; Sunnu et al., 2023), which suggest that a water concentration of between 5% and 20% is optimal for improved briquette performance.

Because ash presence can reduce the calorific value of briquettes, it reduces their quality. The residue of combustion that has neither carbon elements nor calorific value is called ash content. The primary constituents of biomass ash are silica, calcium, potassium, and magnesium, all of which have an impact on the combustion's calorific value. Because ashless fuels – like gas and oil – have superior combustion qualities, ash concentration is a crucial factor. The quality of the briquettes increases with decreasing ash concentration. From the content testing results, sample 1 had an ash content of 33%, whereas sample 2 had an ash level of 29%. This indicates that pressure has no effect on the amount of ash. The ash can prevent air from entering the furnace, slowing down the pace at which the briquettes burn. Unless the furnace is shaken often to remove the ash while cooking, a lower ash level is desirable, while an excessive amount presents issues during combustion. This is also because the tapioca glue that was utilized added ash. Because it can lower the briquettes' calorific value and burning rate, a high ash concentration will result in scale and may lower the quality of the briquettes produced.

**Table 2.** Volatile matter content, heating value, ash content, and carbon content of briquettes

| No | Parameter | Test result | |
|---|---|---|---|
| | | Sample 1 | Sample 2 |
| 1. | Water content (%) | 16 | 12 |
| 2. | Ash content (%) | 33 | 29 |
| 3. | Carbon content (%) | 2 | 11 |
| 4. | Calorific value (kal/g) | 2390 | 3009 |
| 5. | Flying substance levels (%) | 65 | 60 |
| 6. | Density (gr/cm$^3$) | 0.539 | 0.337 |
| 7. | Compressive strength (gr/cm$^2$) | 13.26 | 15.3 |

The amount of smoke produced during combustion may be measured using the level of volatile materials as a metric. The amount of smoke produced by a fuel increase with its volatile chemical content. High temperatures during combustion can cause compounds to easily evaporate, which is one chemical component that impacts large amounts of volatile substances. Based to the test results, there were 65% and 60% of flying chemicals in sample 1 and sample 2, respectively. The quality of the briquettes increases with decreasing volatile matter content. The process of drying also has an impact on the number of volatile substances. The briquettes' water content reduces with extended drying time, which also lowers the amount of volatile compounds present. The decrease in water content is the cause of the drop in the number of volatile substances. The number of volatile materials collected increases with tapioca concentration.

The quantity of carbon content in briquettes is determined by the value of the ash content and volatile matter content in the briquettes, as carbon content is a component of the carbon fraction (C) present in materials other than water, ash, and volatile matter. Measurements of a material's carbon content indicate the amount of solid remains after the volatile components have been eliminated. According to the test results, sample 1 of the briquettes has a carbon level of 2%, whereas sample 2 has an 11% carbon content. Because the amount of carbon affects the calorific value, it is a measure of fuel quality. The fuel will be of greater quality since the bound carbon content increases with the calorific value. The grade of the briquettes increases with their carbon concentration. It is possible to affect the carbon content value when mixing. The drying process has an impact on the carbon concentration as well. The following is a comparison of the physical properties of the briquettes in this study with faecal sludge-derived char briquettes (Fig. 5) (Mwamlima et al., 2023).

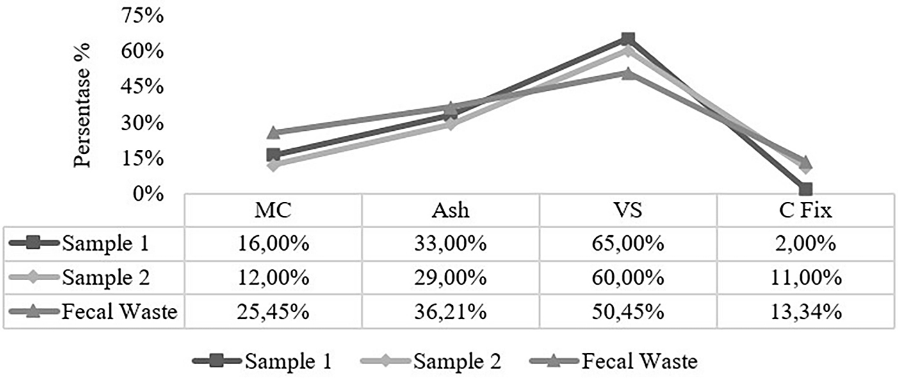


**Figure 5.** Comparison of the physical properties of briquettes in this study with faecal sludge-derived char briquettes

### *Density and compressive strength of briquettes*

In producing and utilizing briquettes, particularly biomass briquettes, two characteristics are measured: density and compressive strength. The weight of briquettes per unit volume is referred to as briquette density, and it may be expressed in a few ways, including grams per cubic centimeter ($g/cm^3$) or kilograms per cubic meter ($kg/m^3$). Sample 1's briquette density is 0.539 $g/cm^3$, whereas sample 2's briquette density is 0.337 $g/cm^3$. Denser briquettes often have a higher heating value and can yield better energy-efficiency outcomes.

Briquette compressive strength tests are used to determine how well briquettes can sustain loads or pressures. Figure 6 illustrates how the compressive strength of briquettes is measured. Briquettes for sample 1 have a compressive strength of 13.26 $g/cm^2$, whereas sample 2 has a compressive strength of 15.3 $g/cm^2$. Because of their high compressive strength, briquettes may be efficiently employed in a wide range of applications and are also more resistant to mechanical impacts. Briquettes' density and compressive strength can be affected by a few variables, including as the kind of raw material utilized, the production method, and the circumstances of compaction.

### *Calorific value*

The amount of heat generated per unit weight during the burning of a combustible material is known as its calorific value. The calorific value is the primary factor used to assess the quality of fuel that has been briquetted. The heat generated during the burning of a unit quantity of fuel (mass) that results in ash, $CO_2$, $SO_2$, nitrogen gas, and water; water that turns into steam (vapor) is not included in this calculation. The fuel quality improved with increasing heat. The briquettes' bound carbon content and heating value have a beneficial relationship. In sample 1, the calorific value of the briquettes was measured with the result as 2390 cal/gram, and in sample 2, it came out as 3009 cal/gram. The grade of the briquettes increases with their calorific value. Changes in the amount of additional adhesive utilized can have an impact on the outcomes of the increased

**Figure 6.** Measurement of compressive strength of briquettes

calorific value. The calorific value gained decreases with increasing tapiocaconcentration. The drying process has an impact on the heating value as well. Because there is less water in the briquettes after a longer drying period, the calorific value increases.

### *Briquette burning rate and total energy consumption*

Finding out the way the briquettes function as fuel and how quickly they burn are the two main goals of the thermal test. In order to perform the briquette test on salt, 864 liters of salt water had to be boiled until the salt crystallized. The quantity of fuel burnt when boiling water in a cauldron is known as the burning rate. Another common term for combustion rate is specific fuel consumption. The high heating value briquettes (3009 cal/gram) are the ones that were utilized to evaluate the burning rate. In tests, 84 briquettes had to burn for five hours in order to bring 864 liters of salt water to a boil. According to the calculations' results the briquette burning rate is 3.41 g/s. While total fuel consumption refers to the quantity of fuel used during the thermal testing process to bring the water to a boil. The energy needed to bring water in a cauldron to a boil is known as total energy consumption. According to the energy test findings, 184.8 Mcal of energy are needed to boil 864 liters of water till the water turns salty. Figures 7 and 8 illustrate how salt is made by heating salt water. The combustion flow rate is one of the factors that affects the thermal efficiency value, the higher the thermal efficiency value, the quicker the flow rate.

### *Advantages and disadvantages of briquette*

Briquettes composed of a blend of cow dung, rice husk, and sawdust present both advantages and disadvantages. On the positive side, these briquettes contribute to environmental sustainability by repurposing organic waste, particularly cow dung that is typically discarded, into a valuable energy source. Additionally, the inclusion of rice husk and sawdust as raw materials aids in diminishing agricultural and wood industry waste. The combination of cow dung, rice husk, and sawdust also offers energy efficiency potential, as the resulting briquettes serve as easily combustible fuel. Moreover, the cost-effectiveness of production is a notable advantage, given that the raw materials – cow dung, rice husk, and sawdust – are readily available and inexpensive.

However, there are drawbacks to consider. The production process for these briquettes is more intricate, demanding specialized equipment and processes compared to conventional briquettes. The burning of these briquettes releases an unpleasant odor, making them unsuitable for indoor use. The moisture content in the briquettes can vary, impacting combustion efficiency, with higher moisture content hindering optimal burning. Furthermore, the strength and durability of briquettes from this mixture may be compromised, as they tend to have lower compressive strength compared to other types. Lastly, the public perception of collecting and processing cow dung and other materials for briquette production may be unfavorable, posing a challenge to widespread acceptance.

**Figure 7.** Cauldron where salt is cooked

**Figure 8.** Kitchen where salt is cooked

**Table 3.** Business capital for making briquettes from a mixture of cow menure, husks and wood dust

| No | Equipment | Quantity | | Unit price | Amount (Rp) |
|---|---|---|---|---|---|
| 1. | Land | 300 | $m^2$ | 100.000 | 30,000.000 |
| 2. | Licensing | 1 | Package | 3,000.000 | 3,000.000 |
| 3. | Building | 64 | $m^2$ | 1,000.000 | 64,000.000 |
| 4. | Drying floor | 100 | $m^2$ | 250.000 | 25,000.000 |
| 5. | Briquette press machine | 1 | Unit | 8,000.000 | 8,000.000 |
| 6. | Mixing container | 1 | Unit | 500.000 | 500.000 |
| 7. | Shovel | 2 | Unit | 100.000 | 200.000 |
| Total | | | | | 130,700.000 |

**Note:** Source – primary data (processed), 2023.

## Briquette feasibility analysis

### *Investment costs*

Investments with an extended useful life are known as investment expenses. The one-year time restriction is based on the capacity to plan and execute the budget for a one-year period; often, the time for investment costs is set at more than a year. The business for making briquettes from a mixture of sawdust, husks, and cow menure needs an investment of Rp. 30.000.000 to purchase 300 $m^2$ of land; in addition, a Rp. 3.000.000 licensing fee is required; Rp. 64.000.000 is needed to construct the building; and Rp. 33.700.000 is needed to purchase equipment. The business capable of making briquettes from a mixture of sawdust, husks, and cow menure requires IDR 130.700.000 in total investment expenses.

**Table 4.** Fixed costs and variable costs of the briquette making business

| No. | Description | Per year (Rp) |
|---|---|---|
| 1. | Fixed cost | 7,388.571 |
| 2. | Operational cost | 24,307.200 |
| 3. | Labor costs | 48,000.000 |
| Total | | 79,695.771 |

**Note:** Source – primary data (processed), 2023.

### *Working capital*

Fixed costs are expenses that the business unit that manufacturing briquettes must pay on a regular basis over a predetermined length of time or throughout each production. The expenses that will be incurred in operating a briquette manufacturing firm are listed in the table below.

Table 4 shows that the annual variable expenses for the company of producing briquettes from a blend of sawdust, husks, and cow menure are Rp. 24.307.200. The highest expense is the procurement of raw materials for cow menure in a single year, total 7.120 kg/year, as shown in Table 5. According to the specifics of the fixed expenditures spent by the briquette-making enterprise, the business's annual expenses come to Rp. 7.388.571.

### *Analysis of the financial feasibility of making briquettes*

The financial feasibility of the briquette project is assessed using a number of factors, including payback period (PBP), net present value (NPV), internal rate of return (IRR), and net benefit/cost ratio (Net B/C). The computed values, which are displayed in Table 6, are as follows.

- Net present value:

$$NPV = 144.074.566$$

**Table 5.** Variable costs of the briquette making business

| No | Description | Quantity | | Unit price (Rp) | Number of kg/month | Amount/year (Rp) |
|---|---|---|---|---|---|---|
| 1. | Husk | 24 | kg | 100 | 480 | 576.000 |
| 2. | Cow menure | 356 | kg | 150 | 7.120 | 12,816.000 |
| 3. | Wood dusk | 44 | kg | 100 | 880 | 1,056.000 |
| 4. | Tapioca flour | 4 | kg | 10.000 | 80 | 9,600.000 |
| 5. | Water | 54 | L | 20 | 1.080 | 259.200 |
| Total | | | | | | 24,307.200 |

An increased NPV suggests that this project has the potential to be profitable. An elevated net present value (NPV) signifies that the project's net cash flow current value surpasses the initial investment expenses.

- Internal rate of return:

IRR = 72.154%

The expected rate of return on an investment is shown by the IRR. A great rate of return is indicated by a high IRR (72.154%) in this situation, which is suggestive of the project's feasibility.

- Net benefit/cost ratio:

Net B/C = 4.37

A high benefit-to-cost ratio (greater than 1) suggests that the advantages of this project will outweigh the expenses. In this instance, there is a net gain of 4.37 currency units for every currency unit invested.

- Payback period (PBP):

PBP = 3.22 years

The time required to recover the initial investment is indicated by the payback period. The investment returns faster with a shorter PBP. Considering that the PBP is just 3.22 years, this is a comparatively short time to recover the investment. Overall, the briquette project has great feasibility indicators, including a short PBP, good Net B/C, high IRR, and positive NPV. This demonstrates the value of continuing with this project.

**Table 6.** Investment criteria for building a briquette making business

| No. | Criteria | Unit | Value |
|---|---|---|---|
| 1. | NPV | Rp/project lifespan | 144,074.566 |
| 2. | IRR (%) | % | 72.154 |
| 3. | Net B/C | Ratio | 4.37 |
| 4. | PBP | Year | 3.22 |

## CONCLUSIONS

Sample 1 briquettes had a water content of 16%, whereas sample 2 briquettes had a water content of 12%. Because the results of this water content test fall between 5% and 20%, they are still considered satisfactory. According to the test results, sample 1 had an ash level of 33% and sample 2 had an ash value of 29%. According to test results, there were 65% and 60% of flying chemicals in sample 1 and sample 2, respectively. The quality of the briquettes increases with decreasing volatile matter content.

According to the test results, sample 1 of the briquettes has a carbon level of 2%, whereas sample 2 has an 11% carbon content. Because carbon concentration affects the calorific value, it is a measure of fuel quality. The fuel will be of higher quality since the calorific value increases with the bound carbon concentration. Sample 1's briquette density is 0.539 g/cm$^3$, whereas sample 2's briquette density is 0.337 g/cm$^3$. Briquettes for sample 1 have a compressive strength of 13.26 g/cm$^2$, whereas sample 2 has a compressive strength of 15.3 g/cm$^2$. Because of their high compressive strength, briquettes may be efficiently employed in a range of applications and are also more resistant to mechanical impacts.

Overall, the briquette project exhibits outstanding feasibility in terms of the financial feasibility study of briquettes, as evidenced by its positive net present value of Rp. 144.074.566, high internal rate of return of 72.154%, good Net B/C of 4.37, and relatively high PBP of 3.22 years. This demonstrates the value of continuing this endeavor. For industrial-scale production, it is recommended to utilize automatic mixing machines and automatic briquette molding machines to meet large-scale production needs. In addition to being used for salt processing, briquettes can also serve as fuel in ovens for drying harvested crops. Moreover, in regions with winter seasons, they can be utilized for room heating (chimney smoke). It is envisaged that emissions testing of briquettes made from a blend of wood dust, rice husks, and cow menure will take place in the future. The gas composition of the briquettes will be subjected to testing in the following research, following the research roadmap that the researcher has designed.

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